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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

APRIL 16.

The Ceramic Society, Stoke-on-Trent:—Ordinary meeting at Stoke-on-Trent. "Researches on the Theory of Fine Grinding." Parts 9, 10 and 11. Paper by Dr. G. Martin, F.I.C., F.C.S.

Institute of British Foundrymen.

APRIL 5.

London Branch:—Annual general meeting in London.
West Riding of Yorkshire Branch:—Ordinary meeting at Bradford. "What has Science done for the Foundry?" Paper by W. H. Poole.

APRIL 10.

Lancashire Branch, Burnley Section:—Annual meeting, followed by an Open Discussion.

Where the Fallacy Lies.

We revert periodically to the question of costs as a factor too often ignored in the foundry trade to its very great disadvantage. Orders necessitate quotations, quotations necessitate estimates; estimates may be shots in the dark or they may be based on accurate knowledge of costs, in obtaining which latter knowledge some degree of expenditure and organisation is involved. The small founder must ask himself whether this is worth his while, or whether he gets along well enough on the good old hit-and-miss principle of averaging.

It is true that prices depend on the market—on the buyer rather than on the cost of production—but it is also true that only a firm aware of its costs can afford to quote under price, because it alone knows what it is doing. The jobbing founder is in a very difficult position, because he least of all can afford to go on the usual principle of selling by weight. Where weight, amount of labour, and complexity of design vary from one casting to the next, how can one price be satisfactory?

The first element in cost of production is direct labour, which should ideally be ascertainable for and charged to each job; the second is indirect labour, which must be distributed over all jobs as a percentage overhead. Then there is direct material, which should also be charged to each job, and indirect material, which has to be distributed like indirect labour. Finally, another overhead charge has to be added for supervision, estimating and selling costs, depreciation of plant, profits, etc. The details of cost building will vary in individual cases, but clearly no single item can be neglected or cut without greater or lesser risk of disaster. Yet we repeatedly find founders taking orders at prices which they must know to be uneconomic; on the ground that they are thus able to "keep the organisation together," or "meet the overhead," and that therefore it pays them to do so. Where is the fallacy?

Fallacy there must be, since the better a man knows his costs the less disposed is he to take orders below them. But how can one bring home the idiocy of such procedure to the man who is ignorant of true costs?

Let us suppose that it costs a founder (whether he knows it or not) £100 to fulfil a given order, and he takes it for £90. The difference of £10 is really borrowed to help keep things going, and is as much a loan as if he had been compelled to borrow it from the bank in order to make the job possible. He cannot avoid paying for direct and indirect labour and material, so that the £10 really comes off profits, depreciation, and those other elements of cost which, because they are difficult to ascertain, seem so nebulous to the small founder. He is really encroaching on his capital, and the day of reckoning comes when he wants to replace worn-out plant or develop his business, and has nothing in the till to do it with. It may be that in many cases a return of prosperity will enable such loans to be met out of excess profits, in which case the gamble appears justified. It must, however, be clearly recognised that it is a gamble to take business below cost, and that is a form of business optimism which the bankruptcy returns do little to encourage.

Let every founder who is tempted to take business below cost regard it as a case of borrowing from the bank and paying interest on the difference between an economic and an uneconomic price. There is nothing against a man who is making at very low costs selling accordingly; and selling below cost may even at times be a business necessity. But to do it persistently is commercial suicide, to do it persistently in ignorance is to live in a fool's paradise, since the measure of risk is never accurately known. Accurate cost information is essential to prevent this, as well as a common system of obtaining it.

A Tested System.

We recently published from an American correspondent a letter strongly deprecating an attitude we had adopted in reference to an American effort to teach students the actualities of works' practice during professional qualification. We have recently had a talk with a civil engineering student who complains that though he can make 95 per cent. in his directly-applicable subjects, he finds that the rest of his studies—electrical engineering and theory of machines and the like—are not only a drag upon his already limited time, but a tax on his knowledge-absorbing capacity. This is just what we expected, and falls into line with our own experience. We still believe that the ideal system is to ensure a good general education before starting on a professional course of study—a factor usually assured by the matriculation or similar examination. Then the professional course should be made as directly applicable in theory and practice as the potentialities of the career will allow. If, as is essential, the interest of the student has been aroused and maintained, then he will continue to pursue his studies on direct and allied subjects after qualification. Any attempt to impose upon the student knowledge required in any one particular section of any one particular industry is too limiting in outlook, and is likely to narrow the student's viewpoint to unprofessional limits, whilst conversely too wide a curriculum is liable to make him lose his interest in his studies, whilst, at the best, it merely generates a theoretical jack of all trades and a practical master of none.

We are confident that an examination of the careers of many engineers and founders who have been successful will show that their success is due to this arousing of intense interest in their work during qualification, sufficiently so to ensure continuation of study after qualification.

D

Factors in the Design of Castings.

In the course of a Paper on "The Influence of Metals on Workshop and Design Problems," read on the 23rd ult. by Mr. A. H. Goodger, M.Sc., before the Manchester Association of Engineers, the author introduced some interesting notes based upon his experience in foundry practice in regard to the production of iron and other castings. We append a few abstracts:—

How a Casting Cools.

It is very seldom realised exactly how a casting cools in a sand mould, but a clear understanding will often help one to arrive at a solution of many problems. The surface of the mould receives heat from the metal by direct conduction and by radiation, but the sand is a relatively bad conductor and rapidly attains the temperature of the metal. The gases and air in the pores of the sand are heated by contact and tend to rise through the mould by convection. This heated air forms a hot jacket round the casting and causes the top portions to cool less rapidly than the lower parts, provided they are of the same section.

Cast iron, being a material whose strength depends largely on the rate of cooling, may be made to illustrate this phenomenon in a remarkable way. Two similar test bars should be moulded in separate boxes so that they are surrounded by similar thicknesses of sand, and one cast in a vertical position and the other in a horizontal position, using metal out of the same ladle. Most persons would say that the vertical bar would be the stronger, but it will be found on testing them that the horizontal bar will give a strength 20 to 25 per cent. greater than the vertical bar. The hot gases can get away from the horizontal bar, but they form a warm blanket round the vertical bar.

Top Layer of Cast-Iron Castings Inferior.

On many castings which have to be perfectly sound throughout "heads" are used. The function of a "head" is to supply molten metal to a casting to meet all liquid shrinkage. It can only accomplish this satisfactorily if it is sufficiently large to remain fluid after all the rest of the casting is solidified. The function of a "head" is not, as one so often hears, to increase the density of a casting by putting pressure on it. Hydrostatic "head" has little to do with the feeding of a casting, and in fact it has little effect on a metal beyond diminishing the possibility of blow-holes. Density tests taken along a cast-iron bar 20 ft. long, cast on end, showed a small increase from top to bottom and this increase was probably due to the more rapid cooling of the lower end of the bar. In the fluid compression of steel, pressures of 2 tons per sq. in. increased the density from 7.85 to 7.87 and increased the tensile strength from 29.18 to 29.53 tons per sq. in., chiefly by preventing the formation of blow-holes due to dissolved gases. There is no doubt that the metal in the top of a casting is usually inferior to the metal at the bottom, but this is almost certainly due to the flotation of dirt, sand, blacking, bubbles of entrapped air and gas, etc. A "head" is no advantage to a casting apart from elimination of shrinkage defects, and is certainly costly to mould, fill and machine off. Its use is therefore to be deprecated when other methods for obtaining soundness can be used. Where it is essential, however, it is a good plan, if more than one casting is to be made off, to incorporate it as a permanent part of the pattern or strickle boards, and even to have it indicated on the drawing. To send out an inquiry for a casting which it is known requires a "head" without indicating it, and to trust to luck that a perfect casting will result, is certainly bad practice.

Gases Dissolved in Metals.

The solubility of furnaces gases, such as carbon monoxide, is a frequent problem in steel and non-ferrous metals, and as a rule steps have to be taken to eliminate the gases before casting. Generally a small addition of aluminium, magnesium, phosphor-copper or manganese-copper, has the effect of "killing" the metal and making it cast soundly. Nickel alloys are great offenders in this respect, but the addition of a small amount of aluminium or magnesium, about one ounce to 100 lbs., serves to correct the trouble.

The longer the metal is in contact with the furnace gases the greater the quantity of gas dissolved, and nothing is to be more strongly deprecated than allowing metal to "stew" in a furnace until the mould is ready. This is often done with bronzes and gunmetals, with the result that they become absolutely rotten with gas. Aluminium alloys are also very difficult to cast sound from this cause; commercial castings are continually met with which are in effect metallic sponges full of minute gas pores. In this case the method devised by Archbutt, at the National Physical Laboratory, is an excellent cure for gas absorbed during melting. The molten metal is allowed to solidify very slowly in the furnace to allow the gas to be expelled completely. As soon as completely solid, the metal is quickly remelted and castings free from gas cavities are then easily made.

Identifying Trapped Gases.

It is a debatable point whether dissolved gases cause much trouble in cast iron through the range of compositions usually employed for castings. Certainly it is difficult to see how gases such as carbon monoxide or oxygen, even as oxide of iron, can exist in contact with so much carbon, silicon and phosphorus—all energetic deoxidisers. Most of the gas holes found in cast iron are due to trapped bubbles of air or steam from the mould, or from the special case of sulphide inclusions. In metals, trapped air or steam holes can be often recognised microscopically by the small amount of chilled metal surrounding them.

In iron castings irregular patches of a faint brownish-grey tint are frequently met with on machined surfaces, which were on the top side of the mould. In most cases these patches are associated with serious blow-holes. These patches are inclusions much richer in manganese sulphide than the rest of the metal, and frequently are of very large extent. Analyses of such patches show a large increase of sulphur and manganese over the rest of the metal. Manganese sulphide is a normal constituent of cast iron, but unfortunately it has this tendency to rise to the surface of the molten metal on account of its lower density. Judging from the number of castings one sees suffering from the trouble, this constitutes a workshop problem which is not sufficiently understood. The most unfortunate part is the presence of the associated blow-holes, and this is difficult to explain, as sometimes the patches are found without any. Sometimes, though not always, the sulphide is associated with kish or free graphite which has separated in the molten iron. Where this occurs some of the blow-holes are due to mechanically-trapped bubbles of air, but this explanation does not seem to meet all cases.

Artificially Inducing Unsoundness.

The trouble is probably connected with the cause of the blow-holes, which always occur on the top of an open sand casting. The most likely explanation of these is, that oxides formed on the top of the molten metal are carried under the surface by convection currents and react with the carbon in the iron, giving off bubbles of carbon monoxide which attempt to escape. The effect ceases when a top is put on the mould, simply because a skin of metal instantly forms against the top and prevents any air getting at the molten metal underneath. It is probable that the manganese sulphide collecting at the top of the ladle oxidises readily on the surface, and the oxide and sulphide associated together get carried beneath the surface of the metal in the mould, and react with the carbon, giving rise to gas bubbles. This is borne out by the fact that similar unsoundness can be almost always produced at will by the simple expedient of filling a mould completely, allowing to stand for a little while, and then filling up the runner with more metal. This last metal to go into the mould generally carries oxides and sulphides down with it and unsoundness results.

A complete remedy for the trouble would be to use bottom-pouring ladles, or else a lip-pouring ladle with a deep skimming lip. Bottom running has been found by the author to give more trouble than top running, and if the last metal to go in is the cause of the trouble, this is easily explained. The faster a mould can be filled the less likely is any sulphide present to collect in isolated patches. Ladles should be thoroughly well skimmed before pouring, and the use of desulphurisers, such as soda ash, on the top of the metal is an advantage. The total sulphur content of the metal should be as low as possible. It has been found bad practice to drain a ladle into a mould or to use the remains of a large ladleful to run a smaller but important casting.

Effect of Casting Temperature.

It is often stated that cast iron should not be cast too hot on account of the increased size of the graphite flakes, but with the dense and strong irons which are required in important castings to-day, experience indicates that they should be poured as hot as the metal can be obtained. The author's experience with large castings cast from low-silicon low-carbon irons appears to confirm the recent work of Piwowarski, that high-temperature melting of cast iron improves the strength. The "fair" casting temperature is also much modified by such matters as thickness, method of running, size of runners, distance the metal has to travel, etc.

Test Bars and the Testing of Castings.

It is perhaps a sweeping statement to make that no test bar ever truly represents a casting, but it is probably very near the truth. Whatever thickness the bar is made, and whatever its position, if cast on, it is to all intents a separate casting as far as rate of cooling is concerned, and so its strength, which depends so largely on its rate of cooling, will not represent anything but itself. The author has always held, and it is becoming more generally recognised, that the only test bar for cast metals which is of value is one cast under standard conditions, that is to say, cast separately. Generally, of course, it will be stronger than the casting itself; that must be recognised and, if necessary, some standards for comparison obtained by cutting up a casting and testing it. Many engineers like to have a bar cast on so that they can be certain it is cast from the same metal as the casting, but such a bar is of little practical use. If the casting has any decidedly thicker parts in it they will invariably be weaker than the bar. The separately cast bar undoubtedly shows the standard quality of the metal used and gives a true basis for comparison.

"Cats-Whisker" Bars Give High Strength.

The position of the cast-on test bar makes a great difference. If cast on the bottom, sticking out at right-angles, "cats-whisker" fashion, the cooling rate is much greater than the casting and a much higher strength than the casting is usually obtained. In the case of cast iron, nearly double the tensile strength on a very thick casting may be obtained in this way. If cast near the top of a casting the rate of cooling is slower, and there is more chance of the test bar giving a result like that of the casting, but there is always the danger of the test bar forming a pocket for accidental inclusions. The author has found that test bars of cast iron, cast in this way, are often higher in sulphur and manganese than the main body of the casting.

Suggested Specification for Cast Iron.

If an engineer knows what he wants there can be no better way of being certain of a good casting than by specifying the limits of analysis, and, if necessary, the strength of a separately cast test bar. A competent inspection of the casting for defects will then give all that is required. As a matter of works' practice the author casts on all important castings a very short test piece of a thickness equal to the general thickness of the casting, and this is sent up to the laboratory, properly labelled, for check analysis. Where it is broken off right against the casting it gives some guide as to general fracture and may be Brinelled there if necessary. The strength of the material is regularly checked by a separately cast bar.

An Aerial View of Southern Foundries Limited, showing the Works, Housing Estate and Sports Ground.

In 1924, when the house-building boom was at its height, there was started at Purley Way, Croydon, a modern foundry designed to meet the demands for rainwater goods for the very important London market. Known as Southern Foundries, Limited, it started up with many real advantages. Primarily, breakages due to long rail transport, which are such a serious handicap to the Falkirk foundries, were at a minimum. Suitable pig-iron (Northamptonshire) was available, whilst the competition between Welsh and Durham coke ensured reasonable prices, and but little in advance of what is paid in other parts of the country. The works are situated quite near to the Southern Railway, and a goods depôt is situated less than a quarter of a mile away from the works. Like every other new enterprise, it had its inherent difficulties, the chief amongst which was an entire absence of suitable skilled labour, and, moreover, when this was obtained, there was the difficulty in securing adequate housing accommodation. How this has been overcome will be detailed later, but overcome it has.

Layout.

The general layout of the foundry will be seen from Figs. 1 and 2, the former being an aerial view of the works, and the latter a line drawing. The foundry is provided throughout with concrete floors with the exception of one small corner used for jobs which have to be bedded in. This floor allows of internal transport being effected by electric trucks. These have a pulling capacity of 2 tons and have been supplied by Slingsby. The layout has taken into consideration the general existing movement of materials, whilst legislating for future extensions. There are three principal shops devoted to moulding. One is for the making of gutters, a second for fall pipes, whilst the third turns out connections and repetition castings for the electrical industry. This last affair is rapidly becoming an important phase of the company's activities.

Melting Plant.

This consists of three cupolas, the largest of which is 7 ft. diameter and melts at the rate of 16 tons per hour. It has been supplied by the Constructional Engineering Company, of Birmingham, but it is not furnished with a drop bottom. This may seem to be a retrograde step, but, as Commander Withers, the general manager, explains, there is no tradition about a comparatively

A, Timekeeper's Office; B, General Offices; C, Pipe-Moulding Floor; D, Cupola Staging; E, Pattern Stores (on 1st Floor); F, Gutter Moulding; G, Specials and Electrical Castings; H, Fettling; J, Dispatch Stores; K, "Special" Stores; L, Dipping Tank Shed; M and N, Fitting Shops; O, Pattern Shop.

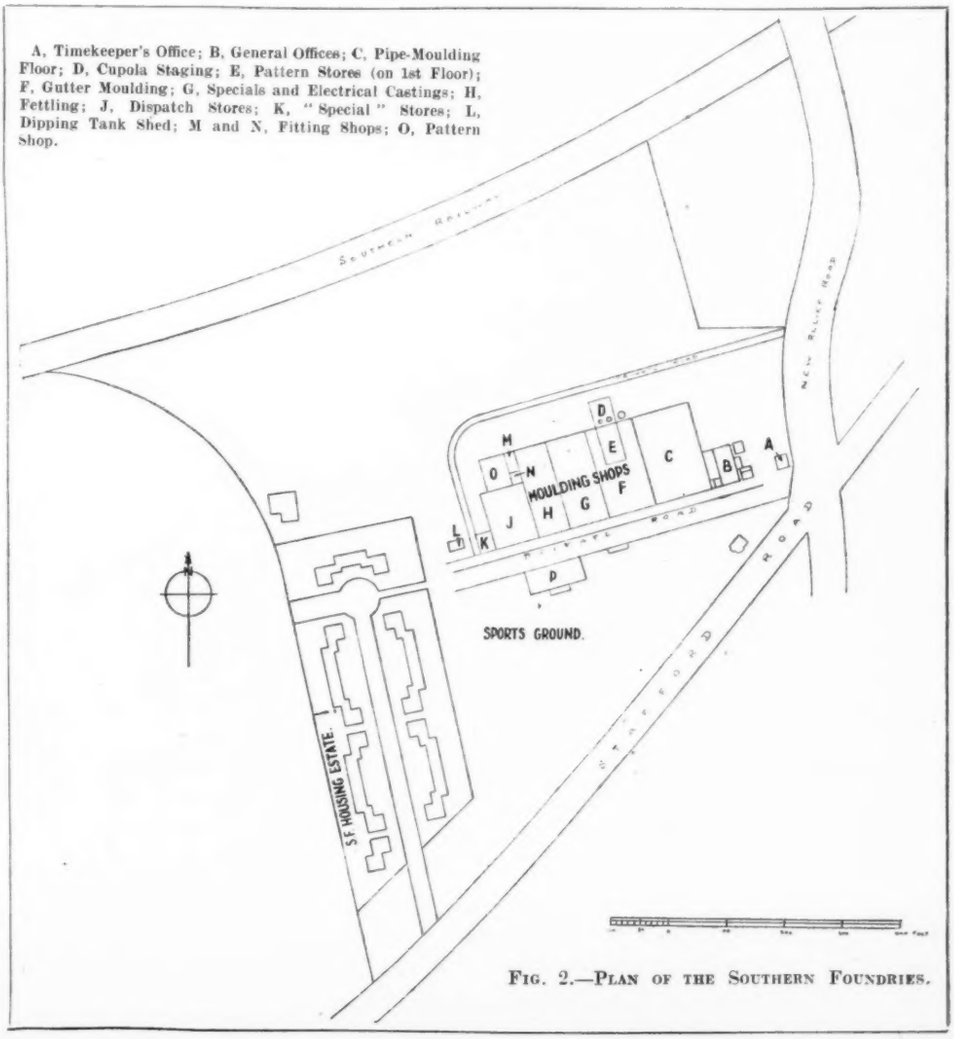


Fig. 2.—Plan of the Southern Foundries.

new foundry, and having experienced waste of time and effort—his production schemes spoilt by accidents with a drop bottom—he decided to minimise all risk and sacrifice modernity to sure production. This cupola is shown in Fig. 3. The two other cupolas have diameters of 5 ft. 6 in. and 5 ft. diameter respectively, and are a modified "Whiting" design. Air is provided by a series of Keith, Blackman fans, which can be coupled up easily to any of the cupolas. A tilting self-skimming ladle is interposed between the furnace and the bogey ladles, which distribute the metal to the various sections, two of which are shown in Figs. 4 and 5. The raw material, which is

Fig. 3.—Cupola, Showing the Ladle-Filling Arrangements. The Concrete Floors allow of the Easy Transport of this Type of Ladle. Southern Foundries, Limited.

grouped roughly equidistantly around the cupola in the yard, is weighed on the ground floor and sent up to the charging platform by lift. The plant is found to be quite adequate for the foundries' output of 100 tons of finished castings per week.

Moulding Details.

The moulding gutters, fall pipes and connections are well known to the foundry world, and the technique at Southern Foundries follows pretty closely that used in Scotland. The sand for the gutters is turned over at the close of the day and covered according to the individual moulder's idea with new yellow sand, whilst for pipes this is done in the early morning. All the foundry skilled labour is working on a piece-work basis, whilst the unskilled is provided by a contractor. For the pipe connections there are a number of moulding machines in active operation, including two Osborns, two Mumford, two Ajax, and a Tabor.

There is no actual core shop, as the pipe moulders provide for their own requirements. For the electrical and other castings, two stoves are available. The larger is gas-fired, and contains a number of perforated shelves. It is 4 ft. by 2 ft., whilst the second is smaller, being 3 ft. 6 in. by 18 in. This one is much more interesting as it is electrically heated. It contains five shelves, each one carrying its own heating elements, and has been designed by Commander Withers. Its current consumption helps to reduce the price of the lighting supply; a factor relating to a condition quite often encountered in electrical supply agreements. The internal transport is supplemented by a Morris telpher system.

Fig. 5.—Special Bend Moulds Ready for Closing, Southern Foundries, Limited.

Fig. 4.—Gutter Moulding Floor, Southern Foundries, Limited.

Pattern Shop.

The pattern shop, shown in Fig. 6, is exceptionally well equipped for turning out quantity-production patterns. It contains various metal and wood turning lathes, saws, planing machines, and all the usual machines which go to form the equipment of a modern pattern shop. Here an effort is made to put a maximum of patterns on plates suitable for repetition work, utilising plaster metal and finally iron patterns.

Other Departments.

The fitting shop, shown in Fig. 7, is mainly engaged in providing the foundry with definitely interchangeable box parts. It is well equipped with lathes, planers and drilling machines. A small blacksmiths' shop also exists as part of the maintenance department. The fettling shop, situated between the foundries and the stores. Here the work is tackled by a series of grinders and a Tilghman sand-blast cabinet.

The stores are very extensive and are capable of carrying some 200 tons of rainwater goods. The pipes can be coated either by the hot or cold process before despatch, which by arrangement with the railways is effected in cages.

Welfare Work.

The direction of Southern Foundries is to be congratulated not only on having provided a splendid canteen, playing fields, and houses for the operatives, but on having secured their wholehearted co-operation in making the various efforts successful. In the canteen good food is provided in the middle of the day at very reasonable prices, whilst in the evening the men organise concerts, whist drives and other social functions. The question of adequate housing hindered the progress of the foundry from its inception, and the

Fig. 6.—The Pattern Shop, Southern Foundries, Limited.

recent provision of 47 houses and flats has helped to cement the good feeling between the men and management. The houses contain a living room, scullery, three bedrooms, bath room, and peramulator garage, whilst the flats, though smaller, retain the essential features of the houses. They are let at very reasonable prices to the men, and plenty of space is allowed for the moulder to indulge in his favourite occupation of gardening.

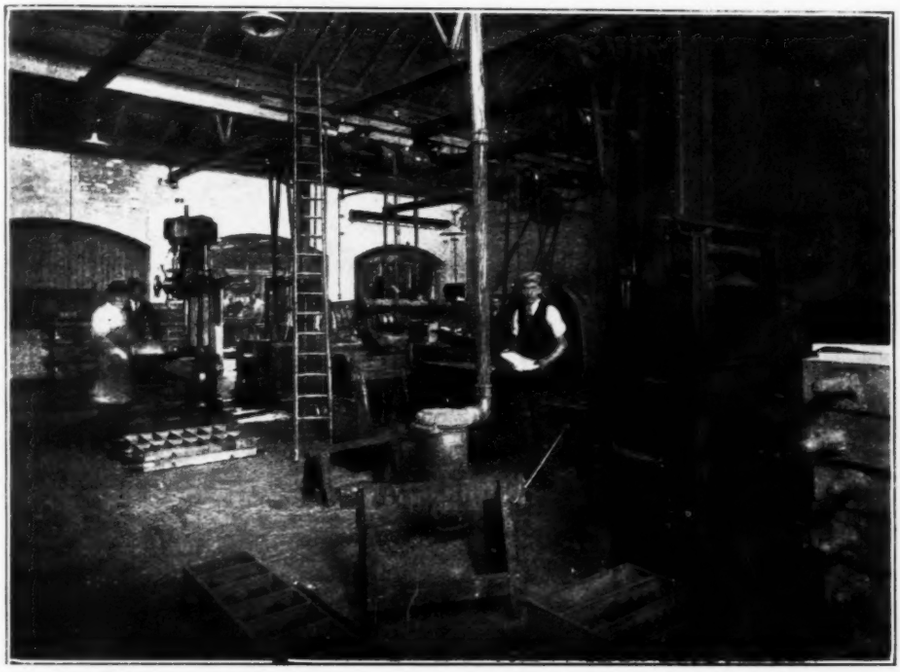


Fig. 7.—The Fitting Shop, which Deals Mainly with the Making of Moulding Boxes and the General Maintenance of the Plant, Southern Foundries, Limited.

The Demag Revolving Electric Furnace.

The Demag concern, represented in Great Britain by Messrs. John B. A. Smeeton, Limited, of 15, Victoria Street, London, S.W.1, has developed a range of simple revolving arc furnaces of considerable interest to non-ferrous founders. Taking brass, gunmetal or bronze as a basis, the capacities manufactured are 2 to 3 cwts., 10 to 15 cwts., and 1 to 1½ tons. They are designated S 25/36, S 60/90, and S 120/180, a unique method, as the figures relate to the cubic contents of the bath melted in litres.

The baby of the series has two graphite electrodes arranged in the horizontal axis, each entering the furnace interior through the end of the drum, the adjusting of which is effected by means of a hand wheel. The arc is formed in the centre of the drum. This furnace is operated by means of single-phase alternating current. It can, however, also be connected to one phase of an existing 3-phase current system, in which case there is an out-of-balance loading of the supply. The electric energy required for operating this furnace amounts to about 125 k.v.a. at a power factor of cos. 0.8-0.9. If three furnaces of similar size operate simultaneously, it would be satisfactory to connect them to each of the three phases of the 3-phase system, thereby attaining a comparatively uniform loading of the supply, but even if only one furnace is connected to a current supply of a 1,000-k.v.a. station, the out-of-balance loading caused is unimportant, especially where it is possible to obtain a load compensation by switching in other single-phase consumers.

The two large furnaces have three graphite electrodes, one of which enters the furnace interior through the one end of the drum (in the horizontal axis), and the other electrodes enter through the other end, but they are inclined towards the axis in such a manner that the arc is formed between the three electrodes at about the centre of the interior.

The adjustment of the electrodes is effected by means of hydraulic cylinders. The control of the cylinders is effected by means of a hand-control device, conveniently arranged immediately in front of, or on the switch board.

These larger furnaces are operated by means of 3-phase current. The 250-k.v.a. at cos. 0.8-0.9 is standard for the requirements of the 10-15-cwt. furnace, and 350 k.v.a. for 1 to 1½-ton plant.

The operating voltage for all the furnaces is 110 volts, and if the existing voltage of the system is much higher, then it requires to be transformed in the usual way.

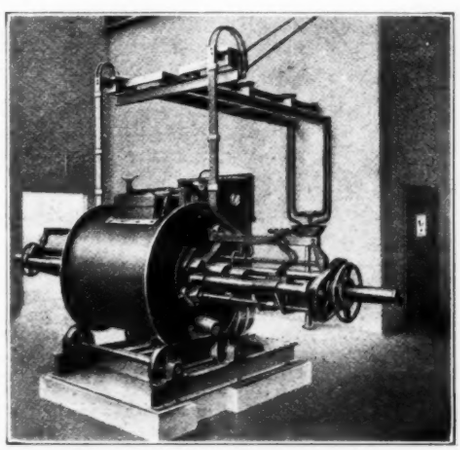


Fig. 1.—The Demag Rotary Electric Furnace.

On account of the high output required by the two larger types of furnaces, it is advisable to connect them direct to the high-tension system, in order that the leads to the furnace switch do not assume excessive dimensions.

These furnaces are specially adapted for melting copper, zinc, tin and lead alloys and high-grade grey cast iron. For 24 hours' continuous running, the following data apply for the individual furnaces, on the assumption that reasonably pure, large-sized material (*i.e.*, no turnings) is charged.

Quantity Melted.—If not more than 15 to 20 mins. are required for charging and teeming, and, at least, 6 cwt., 15 cwt., and 1 ton 4 cwt. of raw material is charged, and if 125 kw., 250 kw., 350 kw. of electrical power is available for each size of furnace, then the the following quantities are claimed to be melted in 24 hours:—

(*a*) Bronze and gun-metal having a casting temperature of about 1,150 to 1,200 deg. C.; with the small furnace, 6 to 7 tons; with the medium furnace, 13 to 15 tons; and with the large furnace, 19 to 21 tons.

(*b*) Brass (60 Cu:40 Zn) with a casting temperature of about 1,050 to 2,200 deg. C. With the small furnace, 7 to 7½ tons; with the medium furnace, 14½ to 15½ tons; with the large furnace, 21 to 23 tons.

Metallic Losses.—For bronze and gun-metal under the above conditions for all furnaces, 0.5 to 1 per cent. of the quantity of metal charged, whilst for brass the corresponding figure would be 1.5 to 2 per cent.

Electrode Consumption.—For smelting: Gun-metal and bronze, under the above conditions, and using the graphite variety. With the small furnace, 2.2 to 4.4 lbs.; with the medium furnace, 3.3 to 5.5 lbs.; with the large furnace, 2.2 to 4.4 lbs.

The corresponding figures when similarly melting brass are 1.5 to 3.7 lbs.; 2.2 to 4.4 lbs.; and 1.5 to 3.7 lbs.

Current Consumption.—For gun-metal and bronze, under the above conditions. With the small furnace, 300 to 360 kwh.; with the medium furnace, 290 to 340 kwh.; with the large furnace, 280 to 320 kwh. per ton metric charged per 1,000 kg. of material charged.

The corresponding figures for a brass melt are 280 to 320 kwh.; 265 to 300 kwh.; and 250 to 280 kwh. per ton charged.

Where turnings of very impure material is charged, the metallic loss increases similarly as with oil, coke or gas-fired furnaces. A corresponding increase in power and electrode consumption also arises, with corresponding reduction of the daily output.

The main advantages claimed for melting metals in the rotary drum furnace as compared with melting in coke, gas or oil-fired crucibles and reverberatory furnaces are:—

(1) Considerably less metallic losses; (2) no annoyance on account of metallic fumes and heat during the melting process; (3) no prejudicial influence on the health of the workmen, as no fumes arise during the melting; (5) easy adaptability to the most varied working conditions. (The furnace can be worked at any time and stopped without injury to the refractory lining, whilst if cheap night-current is available the melting can be carried out during this time, whereby the melting costs are considerably reduced); (6) on account of the great durability of the refractory lining and the possibility of keeping a furnace body in reserve already lined, and being able to change this quickly, there is very little interruption of work; (7) owing to the advantages mentioned under (1) and (6) the melting cost are in nearly all cases lower than with ordinary furnaces; and (8) no impurities can enter the charge from the heating medium (sulphur from the fuel or oxides from excess of air), and therefore high grade material can be produced.

South African Iron and Steel Bill.—The report of the Select Committee of the South African Senate on the Iron and Steel Bill does not favour the establishment of a State-controlled industry. The Committee recommends, instead, a policy of State assistance as embodied in the Bounties Act of 1922, under which, the Committee points out, existing industries have shown a healthy vitality and development. A cable from Capetown states that the Senate has rejected the second reading of the Bill by 18 votes to 15. It is now generally believed that the Government will call a joint sitting of both Houses (as provided under the constitution), and secure the passage of the Bill before Easter.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

The Birth of the Cupola and the Wilkinsons.

To the Editor of The Foundry Trade Journal.

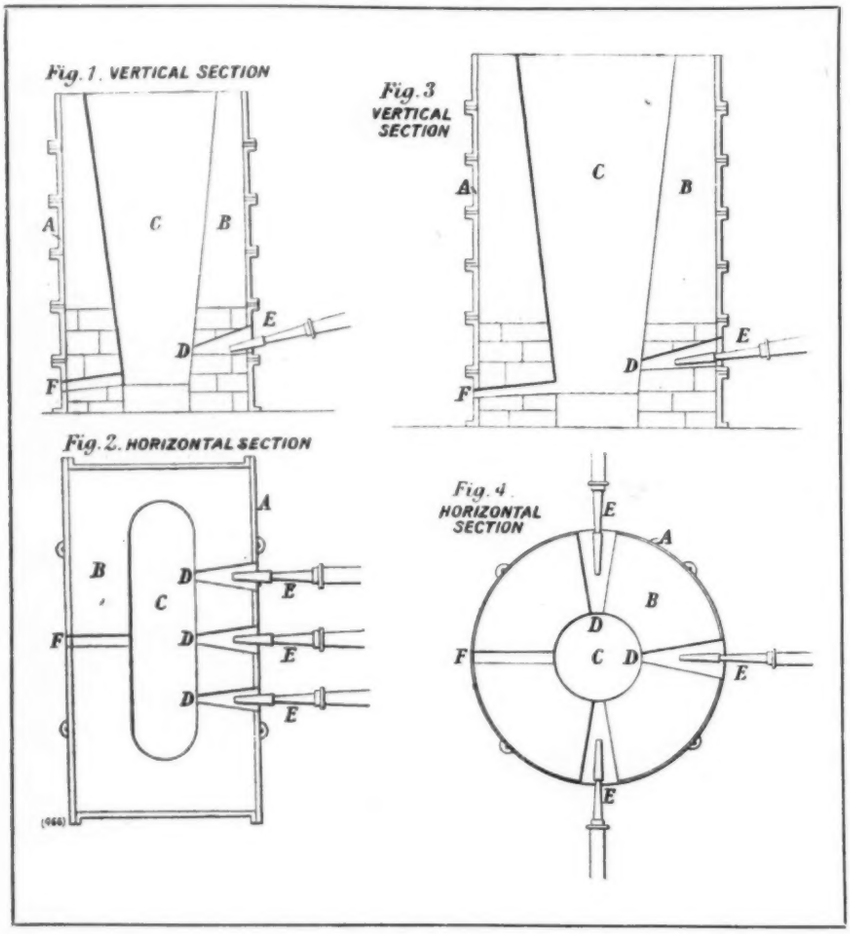
Sir,—Your editorial note in reference to John Wilkinson which appeared in your issue dated March 15, 1928, raises a point of considerable interest. The following is an extract from old papers which are in the possession of the firm Schneider et Cie, and which are in English. This information was published by the firm of Schneider in a book dealing with the history of the firm and which was printed some years ago.

". . . when the works passed into the hands of Messrs. Schneider Brothers, they progressed rapidly, and have steadily advanced until, to-day, they form one of the largest and most perfectly organised metallurgical establishments in the world. The first known document, still in existence, in which the name Creusot is mentioned is a deed of sale, dated 1253, by which Henri de Monestay ceded the "villa de Crosot" to Hughes IV, Duke of Burgundy. At that remote time, Creusot was nothing but a villa or dairy farm occupied by a few persons. This farm was located on valuable coal deposits, the existence of which was only recognised 250 years later (1502). Nearly three centuries later, in 1782, a company was formed under the direct patronage of Louis XVI, for the installation and working of the Royal Ironfoundries of Montcenis, a village near Creusot. It is evident that considerable activity characterised the administrations of the company, which after having acquired the Creusot property, erected four blast furnaces, and *employed the English engineer William Wilkinson, the inventor of the cupola furnace for remelting pig-iron with coke to put his system into operation at the works.*"

This reference to *William* Wilkinson has been confirmed, and, although as far as the British Patent Journal is concerned William Wilkinson cannot possibly be regarded as the inventor of the cupola, it is quite conceivable that *John's* brother *William* was actually the Wilkinson employed at the Creusot works.

The above extract is perfectly definite in referring to William Wilkinson as the inventor of the cupola furnace for *remelting pig-iron with coke*. There is no recorded patent in the British Patent Journal and the only patent is No. 1,993. A.D. 1794, entitled "Manufacture of Iron" in the name of John Wilkinson. This patent is the one usually regarded as the cupola invention, and whilst the drawings and description accompanying the specification bear every resemblance to what we understand as the cupola, the invention is described as a "New Method of Making Cast Metal or Pig-Iron from the Ore, for the Purposes of Manufacturing it into Bar or any Sort of Malleable Iron . . . . ." The illustrations accompanying the specification are given in Figs. 1 to 4, and the specification accompanying these illustrations is as follows:—

"Instead of melting the ore, with additions in "furnaces of 30 to 70 feet high as in the present "method—My improvement or invention consists "in using low erection not exceeding 10 feet high "of a form either circular oblong or square in "which any kind of ore or fuel may be smelted "and in which a strong blast is introduced at "two or more places called Twires, which are "varied in number as the nature of the ore and "fuel may require. Any workman in the present "method may from this description alter his fur-"nace to the quality of his materials. A draw-"ing of two with three Twires is given as a "specimen which may be altered in height and "Dimensions with addition of Twires as to the "Workman may appear needful."



Refferrence. To Furnace No. 1.

A.—Cast iron plates forming the outside of the furnace.

B.—The luteing or inside walls made of sandstone firebrick or any other kind of material suitable for the purpose.

C.—Cavity for fuel and the *ORE* to be smelted.

D.—Twire hole through which the blast is admitted to the furnace.

E.—The blowing-pipe by which the blast is brought to the furnace.

F.—The tap hole or vent for the metal.

N.B.—The same description is applicable to Furnace No. 2, varying in no other particular than in the form or shape the one being oblong and the other circular.

The italicising of the reference to ore in the above specification and description has been done by the author and calls attention to the important fact that nowhere in this patent is the furnace referred to as a *cupola furnace for remelting pig-iron with coke* and the primary intention of the furnace is clearly that of smelting ore direct.

The reference to William Wilkinson in the Schneider publication when considered in conjunction with this description of John Wilkinson's furnace invention, really raises two interesting questions: (1) Was it John's brother, William, who was employed at Creusot, and (2) was John's brother, William, the one who adapted the short length shaft furnace to the remelting of pig-iron with coke as distinct from the direct smelting of ore? Bearing in mind the well-known fact that the two brothers quarrelled bitterly, and also that William was closely associated with Matthew Boulton, which association would account for his continental travels, it is quite conceivable that the answer to the above questions might be in the affirmative.

On the other hand, Mr. George T. Lawley, whose maternal grandfather was cashier to John Wilkinson at his Bradley works, tells us in one of his articles on John Wilkinson, "Wolverhampton Chronicle," March 10/23, that: "In 1785 he "(John) went to France by invitation of the French "Government, and at Cruesal?? he personally "superintended the erection of Watts' steam "engine, the first of its kind in that country. In "a letter dated Cruesal?? Sept: 13th, 1785, he "wrote: 'The engine is in operation, and the "Frenchmen are delighted. It is a complete "success, and the numerous visitors, among whom "were the Duc d'Augouterre, M. Bertrand and "others, expressed their great satisfaction. I "wish you had been there.' He (John) contracted "for and supplied the pipes for the Paris water "works, and so pleased were the authorities with "the work at its completion, the Municipal Coun-"cil gave a grand banquet in his honour. From "one of his letters we learn that this banquet "was held in the Hotel de Ville, July 14th, 1786."

These dates, referring to John's sojourn in France, are at least 8 years before the date of his British patent. There are, however, so many discrepancies in the various fugitive accounts of this celebrated man, and the authentic origin of the cupola as an instrument for remelting foundry pig-iron is a matter of interest to every foundryman, that any further light on this matter would be a valuable contribution to ironfoundry history. The writer's own opinion is that, broadly speaking, John Wilkinson was no doubt the first individual to perceive the necessity for a smaller and more manageable unit than the blast-furnace to meet the demands of organised foundry production. That his cupola, as described in the patent specification, does not comply with our modern restricted definition of the foundry cupola, and the fact that he was probably preceded in his invention by the itinerant moulders of that time, does not justify us in withdrawing from him the title of the inventor of the cupola. It is impossible to imagine that so versatile a genius refrained from using his furnace for remelting pig-iron and scrap castings, which latter must have been made even in his foundries.

Yours, etc.,

J. E. Hurst.

Centrifugal Castings Depart.,
Newton Chambers, Limited,
Thorncliffe, near Sheffield.

A Pipe Moulding Proposition.

To the Editor of The Foundry Trade Journal.

Sir,—I have read with great interest the article, "Sea Sand Cores," in March 1, 1928, issue of the Journal. With 30 years' experience in the foundries in many towns of England I think the foundry has progressed as much as any other part of the engineering trade, when it is realised the foundry depends on the drawing office for the design; on the pattern shop for the patterns and strickles, and on the machine shop for the reception of its output. I have in mind a machine shop foreman who insisted his department could not cut off a head from a cylinder casting as requested by the foundry management. Thus the head, instead of being a foot long, was only about 3 in., and bad castings resulted. Later on the cylinders cast with foot of head resulted in all three being satisfactory. They weighed about 10 tons each. Such actions retard foundry progress, whilst many similar cases to be associated with the pattern shop and drawing office could be cited. Moreover, there is the present excessive rush, especially where hand work is practised. If a moulder is called off for a moment the job is stopped, but not so as with a mechanic, his work usually proceeds. A job is made to-day in much less time than it was years ago, and, moreover, the work is more complicated. Every moulder and coremaker must admit that sea sand is a good thing for the foundry. The pipe in question can be regarded as a repetition job with the number required. The suggestion of making the pipe in three pieces might have cheapened the job, but why not use two pieces and two elbow pipes, then one can cheapen the job much more, as most experienced moulders can make a pipe.

The draughtsmen sometimes are to blame for lack of profit on a job owing to wrong design from the foundry viewpoint, whilst the casting would still fulfill its purpose.

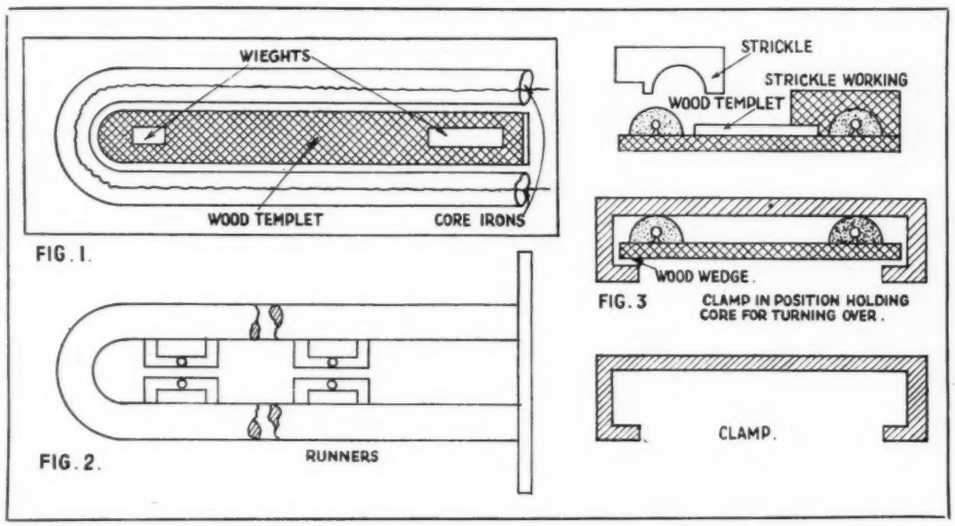
Making this pipe with two elbows would cheapen both the moulding and coremaking by more than half, and obviously involve considerable saving on the order of 100, as stated in the article. No core iron is required, which also saves labour and metal. The core for the pipe, shown in Fig. 1 in your March 1 issue, does not require a special plate as shown. This core can be made from a set-off, *i.e.*, from a wood template for the centre, and a set-off strickle, as shown in Fig. I. Any flat plate will answer if sufficiently large. There could be two on one plate, as turning over presents no difficulties.

Making this core in oil sand is costly, say 4s. per cwt. for oil sand alone. The two elbow cores would be about one-third of the price.

The author, "Sprig," apparently disapproves of vents as being totally unnecessary. Ease of inclusion apart, I suggest that if left out, and working with a solid unvented core, failure to produce a sound casting is certain. Gas is generated too quickly, and it would not be able to get away sufficiently quickly at the loop end. I have had this experience with other jobs, and these have not been devoid of vents, but they were insufficiently large, and the mould would blow until the air has been removed. It is advisable to run the metal through the mould until this is accomplished. Now, as to the running of this pipe, I should hesitate to follow "Sprig's" practice, as I consider the runner is wrongly placed.

Fig. 2 below shows what is thought to be an improved method over the one described by "Sprig," as his arrangement of the runners is liable to break the casting by hindering contraction. Moreover, the fixing and holding down of the chaplets, as described in the article, is by no means novel.

The design of this job could be altered to incorporate elbows, which is by far the better way, both in respect to cost and labour saving. But if it is impossible and one was compelled to make it by the author's method I still cannot agree with him in several details. For instance, it is proposed the running of the pipe should be done, as shown in Fig. 2, "Sprig's" coremaking methods: his statement that oil-sand cores do not require venting and the necessity for spending money making tackle for turning the core over are all definitely controversial, the last phase is shown in Fig. 3. Much detail set out in the rest of the paper depends on the design of the casting.



This pipe could be made in any small foundry, say one employing four or five moulders, but I am afraid they could not afford to spend the money necessitated by "Sprig's" method, as it could be made much simpler and cheaper by many ways. But, after all, I welcome practical papers in the Journal written by practical men, as finality is apparently as difficult to attain as in theoretical considerations.—Yours, etc.,

A. S. (Bolton).

March 7, 1928.

Obituary.

The death took place on March 23 of Mr. Henry Rose, retired ironfounder, of Peasholm Rise, Scarborough, in his ninety-seventh year.

Mr. Ernest Ott, of 15, Park Avenue, for about 30 years a valued official at Hadfields, Limited, Sheffield, died last week in his fifty-first year.

A paper on "Recent Developments in Alloy Steels," by Sir Robert Hadfield, Mr. W. B. Pickering, and Mr. S. A. Main, was read at the meeting in Leeds of the North-Eastern Centre of the Institution of Locomotive Engineers.

Mr. Kenneth Fraser, managing director of the Yorkshire Copper Works, and chairman of the Leeds district of the F.B.I., and Mr. S. E. Illingworth have been nominated as additional vice-presidents of the Federation.

Random Shots.

We have been repeatedly assured of late of the profitable nature of gramophone shares. I am not going to dispute the fact, but I fancy it would be a little less certain if the following little story were as typical as it is amusing:—

Manager: Duncan, please stop whistling that infernal tune you've been murdering lately. And what is it, anyway?

Clerk: I'm sorry, sir, but I've got a gramophone at home, and that wee tune's ma record.

* * *

As a matter of fact, such self-control is practically never found in the real gramophone maniac. Of all hobbies, of all crazes, surely it is the worst—for those who do not share it. To begin with, it is the sort of hobby that a man can't possibly keep to himself. Not, that is, unless he can afford a sound-proof room or an empty house ten miles from anywhere in which to indulge it. To go on with, it takes time, and it will continue to take time, in spite of the new device that turns the handle for you, or whatever it does do. And to end up with, it costs money, and more and more money, from the moment the monster first enters into its kingdom, money for repairs, and for gadgets, and, above all, money for records. It is said that gramophones are not popular with wives: possibly no very acute powers of analysis are required to see why.

* * *

Talking of devices for turning handles, isn't there a profitable future for the man who discovers how to harness some such device to the common or garden barrel organ? Twenty years ago these were the preserve of cheerful and highly coloured Italians, who included in their stock-in-trade the necessary monkey and some vestiges of national dress; they usually managed to appear as if they were enjoying themselves, at least, as much as the youngsters who danced to their uncertain measures. But to-day there are no monkeys and no Italians: few children dance in the roadway when the barrel-organ appears, and the performer makes not the slightest effort to appear amused. The barrel organ is another of the simple pleasures of the past that accords ill with our modern sophistication: the wireless and the cinema between them have reduced it to very small beer.

* * *

Cautionary Tales for Ironfounders (with apologies to Mr. Hilaire Belloc).

The Tale of Andrew, who made Mud Pies.

The trouble with young Andrew Grice
Was making endless large mud pies.
At first in the backyard he tried it,
Until his fond mamma espied it;
At school he dabbled next in clay,
But even there they said him nay.
He sought to learn the building trade—
To that a speedy end was made,
For, shouting vainly for young Andy,
The builder found him being handy
At making mud pies with the mortar.
What next? His mother thought they oughter
Try bakery; if mud-pies why
Not loaves and cakes? At least they'd try.
Alas, he was no use at all,
And back again did Andy crawl.
And then his uncle came to stop—
"The place for you's a moulding shop,
My lad," said he. They tried it gladly,
Hoping it would not turn out badly.
A moulder now is Andrew Grice,
His boys obey him in a trice.
A warning this to every parent
To seek a lad's most natural bent.

* * *

I make no apologies for lifting this from a recent "Punch"—it deserves a better fate than to moulder in such classical obscurity.

A seaside visitor said to the oldest inhabitant. "I hear you will be 85 this year—when is your birthday?" "Well, miss," the O.I. replied, "'e varies, an' I can't rightly say, not till I looks at they almanacks. You see, I was born on Easter Day!"

Marksman.

Moulding by Sand-Slinger Machine.

At a meeting of the Newcastle Branch, Mr. D. Sharpe (Member), of Glasgow, read a Paper on "Ramming Moulds by Sandslinger," the lecture was illustrated by lantern slides and a cinematograph film, and was printed in our last issue.

Mr. R. O. Patterson said that he had found Mr. Sharpe's Paper and the film very interesting, although the method was not a new one to him. His firm had been using two sandslingers for some time, and he could confirm everything that Mr. Sharpe had shown them. Personally, he thought it was the most labour-saving and humane machine he had ever seen. After finishing a day's work by the old methods the men left work tired out, but after doing the same work with the sandslinger they were quite fresh. One of their machines was of the tractor type, and the other of the motive type, each having their individual uses. They used the tractor machine for jobbing work, although they also used it for what Mr. Sharpe had called "quantity production work." The only question he would like to ask Mr. Sharpe was as to whether he had formed an opinion why the Scottish bath makers were not so successful as those of America in using sandslingers on bath production.

Bath Tub Making.

In reply to Mr. Patterson's question, Mr. Sharpe said that in his mind the trouble in bath manufacture in this country was a commercial proposition. A second grade bath was sold at a lower price than a first-grade one. The difference between first- and second-grade baths was that if a flash lamp was held so that the light was in line with the surface of the enamel, waves would be seen on the surface of a second-grade bath just like those seen on the surface of the road when driving a motor at night with bright head-lights.

The Question of Facing Sands.

Mr. J. W. Frier asked Mr. Sharpe if he had ever been called upon to demonstrate the utility of the machine in a marine foundry, and for making cylinders and bedplates, those being looked upon as being one of the most difficult classes of castings to be made. Would it be possible to use the sandslinger for making a bedplate, weighing anything from 25 to 30 tons and moulded in a pit, say, 8 or 10 ft. deep? He had noticed that all the sand used in the machine was of the same grade, that was, really all facing sand. To obtain a skin on a pattern special sand had to be used. How would that be managed with a sandslinger? The quantity of sand required to fill up the pit for each job would range between 20 and 30 tons. In setting the sand up to a pattern, there was generally 4 to 6 in. of facing sand used. Would the impact of that sand be sufficient to ram the sand already on the pattern? He had noticed from the film that all bars on the boxes were straight, there being no flat ones used. He supposed the bars would have to be altered from flat to straight to suit the machine.

Mr. Sharpe said that he was very glad that Mr. Frier had raised the subject. The sandslinger was actually being used on marine castings, both in iron and steel. They were making very large steel castings for marine work, and were dealing with the facing sand problem in a very simple manner. They were ramming in layers of 1-in. or even less, and building up the face from ¼ in. up to 3 in. with facing sand. With a sandslinger they practised moulding to the pattern as a moulder was taught to do as an apprentice. They had no difficulty with facing sand. As far as a flat surface was concerned, it was riddled on in small quantities to the desired thickness, while on a vertical surface, which it was less important to face, it was gradually built up to it. With regard to the quantity of facing sand and the depth from the pattern to the bars, he would cite a certain case. In making lathe beds, the moulds for which used to be filled with iron, actually pieces of broken pig, to reinforce the walls, this practice had been found to be unnecessary when a hard-ramming sandslinger was used. The boxes must be made with the bars vertical instead of flat or bottom plates could be used.

Impeller Head and Upkeep.

Mr. C. Gresty said that the machine seemed so complicated and ran at such high speed that he imagined the upkeep would be rather severe. That would be more particularly the case with the impeller head. He would like to know of what material it was made, and whether the high speed of the sand caused excessive wear on it.

Mr. R. O. Patterson said that he would like to answer Mr. Gresty's question concerning upkeep. Their experience had been that with the tractor type, which has a slower speed impellor, they had to replace the small tip every other day when the machine was working all day. It was quite a simple casting to make. The motive type had a steel liner and worked at a higher speed, and they found it necessary to renew the liner every two days and to put in a new tip every day. In his opinion the upkeep was negligible for the work done.

Variable Speed Ramming.

Mr. W. J. Molineux confirmed Mr. Patterson's opinion that the upkeep was negligible. In the portable type, which his firm used, there was a blade or tip which they made in a chill mould, and they put a new one in now and again. He had known one last as long as a week, but, on the other hand, sometimes two were used in one day. He would like to say that as regards ramming moulds the sand slinger would certainly do that. He would qualify his remark by saying that the job should be suitable for the machine. As there was a great deal of trouble in moving the portable machine from one place to another in their foundry, part of the advantage was lost. Mechanically the machine had been a revelation to him. Apart from the blade he did not think there was any renewal that had been made, except the belt, through wear. He thought an improvement could be effected with regard to the density of the ramming. He thought also that it ought to be possible to vary the speed of the impellor head, say, to lower the velocity of the sand by 25 per cent., to obtain a softer ramming.

Mr. Sharpe, after thanking Mr. Patterson and Mr. Molineux for answering Mr. Gresty, explained that the casting which had to be replaced was a very simple one and could be fixed in a minute or two. There was no machining necessary and it was fastened into place with one bolt. Regarding Mr. Molineux's suggestion of varying the speed, they did that where direct current motors were fitted, but as the drive of the impellor was direct from armature, no variation could be made on motors of 40-cycle alternating current.

Depth and Speed Ramming.

Mr. R. H. Smith asked if in making a cylinder mould 7 ft. deep, rammed by the sandslinger, would there be the same density of sand at the bottom as at the top?

Mr. Sharpe replied that they had to take into consideration the fact that the wad of sand was travelling at a speed of a mile a minute, so that a drop of 8 ft. was really immaterial and therefore the sand would be evenly rammed.

Manganese Steel Impeller Heads.

Mr. Victor Stobie (chairman) asked if experiments had been made using manganese steel for the impellor blade and head, as that material had a finely high resistance to abrasion. He also asked why the man they had seen making the baths wiped the pattern over with paraffin. Mr. Sharpe had not mentioned anything about the price of the sandslinger, and he would be interested to have a general idea of the cost. They had been told of the saving in man-power and the increase in output through the use of the sandslinger, and he thought an indication of the capital outlay would be useful. Also, he would like to know whether any automobile factory in England used the sandslinger in a similar manner to the American ones shown in the film.

Erosion and Abrasion.

Mr. Sharpe, replying to Mr. Stobie, said that it was a peculiarity of manganese steel that it would stand abrasion, but not erosion, and the action of the sandslinger was one of erosion rather than abrasion. Iron tips lasted as long as manganese steel ones, and they were much less expensive. Regarding the price of the machine, they ranged from about seven hundred pounds for a stationary machine to nine hundred pounds for a portable one, one thousand pounds for the tractor type, and up to eighteen hundred pounds and two thousand pounds for the motive type. With regard to automobile factories in England, the Morris 4-cylinder engine was being made, one in every two minutes, from one sandslinger. The men working on that job did not have to move their feet; everything came to them. The Morris 6-cylinder was also being produced in two minutes, but not in normal production. The Standard 6 and 4 were going through about the same production. The Wolseley 6 took three minutes. The moulds were cast in green-sand, which had never been done in the automobile business by any other moulding system in the country.

Mr. Patterson proposed a hearty vote of thanks to Mr. Sharpe, which was seconded by Mr. R. H. Smith. Mr. Sharpe replied briefly, and thanked the members for the interest they had taken in his lecture.

Reconstruction of Old Foundries.

At the February meeting of the New England Foundrymen's Association in Boston, Mr. Clement A. Hardy, engineer, Chicago, gave an address on "New Foundries for Old," in which he declared there is no foundation for the assertion often made that American foundrymen are slow to adopt modern methods, because there has been more improvement and advancement in foundry practice in the United States than in the rest of the world.

Mr. Hardy stated that almost any old foundry could be made into a new foundry at moderate cost, provided there was enough head room to permit the installation of handling equipment. He cited instances of improvements in core-rooms, material yards, sand handling and the various other departments of foundries. Mr. Hardy is in favour of the racked ovens, and said that some 25,000 are in use in this country. He illustrated, with a blackboard, changes just completed at the Builders Iron Foundry, Providence, R.I., where charging has been increased to 25 to 30 tons per day with only three men required for two cupolas.

In changing over old foundries to new, Mr. Hardy said the handling of flasks on the moulding floor and in the yard, especially if the work is medium large, is highly important. It is very often the case that foundries use valuable space for storing flasks in the foundry.

Mr. Earl T. Bennington, manager Cleveland Electric Tramrail Division, Cleveland Crane & Engineering Company, Wickliffe, Ohio, who followed with an address on "Materials and Production Handling in the Foundry," illustrated how five or six different kinds of sand are handled efficiently and economically at the Cadillac Motor Company plant. By this system, which has been adopted by the General Motors Corporation as standard, one man delivers 500 tons of sand per day.

With lantern slides Mr. Bennington illustrated many different ways of handling materials and products in widely-scattered foundries, where grey iron, malleable and brass castings are made. Stress was placed on the push-button control in pouring, with ladles holding 300 to 400 lbs. of metal. Some of the slides depicted handling materials and products in other industries, including wire and rod mills. He stated that the American Steel & Wire Company, Worcester, Mass., is making the largest coils of wire in the world, weighing 400 to 450 lbs., and has capacity for 600-lb. coils to be made at some future date.—"Iron Age" Report.

Before the members of the Diesel Engine Users Association, last Friday, Mr. David Brownlie read a paper on "Liquid Fuel from Coal—An Outstanding National Problem in Great Britain."

Crystallisation of Non-Ferrous Metals.

At the March meeting of the Lancashire Branch of the Institute of British Foundrymen the Branch-President, Mr. J. S. G. Primrose, in the chair, Professor C. H. Desch, D.Sc., gave a lecture on "Crystallisation in Non-Ferrous Castings." The members of the Manchester Metallurgical Society had been invited to attend.

How Metals Crystalise.

Professor Desch, dealing with the solidification of metals, in the course of his lecture said it was important in foundry work to investigate the peculiarities of crystallisation. All castings consisted of an aggregate of crystals, so that the properties of a casting depended not only on its composition but also on the way in which the crystals were arranged. As a rule this arrangement could only be discovered by polishing and etching, and it frequently required the application of the microscope. Particular attention was given to the making of die castings, which are very rapidly cooled by the forcing of the molten metal into a metal die. In the course of an investigation on die castings, it was found necessary to determine more carefully than had been done before certain physical properties of the metals and alloys. One of these properties was the change of volume occurring during freezing. For this purpose a very accurate form of dilatometer had been devised at Sheffield by Dr. C. J. Smith, in which the volume changes in a metal were determined by measuring the difference in expansion or contraction between two similar vessels containing nitrogen, in one of which the alloy was placed. It was found necessary to obtain the metals in a perfectly clean condition for the experiment, and this was done by filtering in a vacuum. Graphs were shown in the lecture illustrating the nature of the volume change occurring in different metals and alloys. By alloying together metals having volume changes in opposite direction it was possible to reduce very greatly the contraction during freezing.

Another investigation dealt with the shape of the crystals in the interior of castings. A statistical comparison between the grains from certain brasses and from chrome steel showed that these grains approximated in form to those of foam cells, the most frequent shape of grain being a roughly 12-faced solid, each face having five sides. As the shape of foam cells was determined by surface tension, it seemed highly probable that surface tension was also responsible for fixing the shape of the grains in castings. This being so, it was desirable that the surface tension of various metals and alloys should be known and determinations of this kind were proceeding at the National Physical Laboratory. Some of them had already been published.

Fluidity of Metals.

The fluidity of the metal was another property of importance in castings, and the various methods of determining this property were reviewed. Experiments on the subject were in progress in Germany and also at Sheffield. It was remarked that the apparent fluidity of certain metals was considerably lower than the true value. For instance, the sluggishness of aluminium was not due to low true fluidity, but to the presence of a thin but extremely tough film of oxide, which behaved as a bag enclosing the liquid metal. It was shown that the fluidity of a metal increased rapidly with the degree of heating above the melting point.

The remainder of the lecture dealt with the presence of internal stress in castings and with inter-crystalline brittleness due to that cause. This part of the subject had been dealt with by the speaker in a Paper read at the Conference of the Institute at Sheffield last year. It was remarked that the brasses and high tensile alloys most subject to brittleness of this kind contained aluminium, but that aluminium bronze itself had not been found to show this brittle condition, at least so far as laboratory experiments were concerned.

Vote of Thanks.

The Chairman said the scientific investigator could not always foresee how far-reaching the results of his work might be. He pointed out the way of improvement, and then the actual progress depended upon the way in which people in the production side made practical application of the discoveries. Dr. Desch had given them ample food for thought and discussion in describing the researches he had made. It rested with the audience to turn the important facts he had set before them to good practical account. He moved from the chair that they should show the heartiest expression of their thanks to the lecturer for having put before them so clearly the results of his latest work on crystallisation.

The vote of thanks was seconded by Mr. T. W. Markland, and passed unanimously with acclamation.

Controlling Grain Size.

The Chairman opened the discussion by pointing out the great importance of controlling the crystal grain size in castings of non-ferrous metals. He made reference to a research on the practical heat-treatment of gunmetal, in which he had been associated with his brother, and cited the great differences in physical properties, including tensile strength, caused by various methods of cooling the test pieces cast on the castings. Variations from 10 to 20 tons per sq. in. were found, which were not due to the irregularity of the material but to the crystalline arrangement modified by the cooling rates. He would ask Dr. Desch to elaborate one point in the statement that copper with aluminium alone in it gave an alloy which did not become brittle. It was known that certain large castings of aluminium bronze were sometimes found in a brittle state due to what was termed "self-annealing." It was the change in the nature of the secondary constituent which brought about this brittleness, particularly when certain amounts of iron were present, so that the aluminium alone might not be entirely responsible. It was well known that in foundries making certain classes of castings, such as gunmetal, the presence of aluminium was considered very harmful, and precautions were usually taken to prevent it getting into the mixture, even for the usual purpose of deoxidation, for which it was employed in certain other cases.

Mr. A. Sutcliffe asked for information upon several points. What was the best mixture for producing an acid-resisting metal? Antimony, arsenic and bismuth were regarded as impurities and undesirable. Were they of any use in any mixing of metal? In brass and bronze all moulds had to be poured very quickly, whether running top or bottom. Why was that necessary? To get soundness in bronze some form of chill or artificial cooling was required. He thought Dr. Desch had indicated the reason for that. Perhaps he would also explain why all brass moulds had to be rammed very well. Why should they be rammed harder than other metals? Was it because of impurities in the metal, such as antimony, arsenic and bismuth? Bronzes had a tendency to eat into the sand badly. Why? What was the best facing for alloy metals, such as brass and bronze? They knew that plumbago and soapstone were good, but what had Professor Desch to say about French chalk? Casting green would be quite a different thing from casting wet and then drying in a stove. In Dr. Desch's opinion what was the best sand to use to stand up against these metals —a red Mansfield sand or a yellow sand? Was there any way of judging brass by the fracture, as was done in iron? It must be remembered that in Lancashire not one brass foundry in a hundred had a chemist, but still they managed to carry on and sell their castings in the market against the foundries where a chemist was engaged.

Effect of Gas on Crystallisation.

Mr. F. Longden said Professor Desch had put before them an excellent exposition of crystallisation in such a way that a practical man could grasp it, and he looked forward to reading the report of the lecture. He joined the previous speaker in desiring information regarding the best mixture for producing non-ferrous acid-resisting metal. Strictly speaking it might be outside the scope of the lecture, but several foundries in the Manchester district were much interested in the question of what metal was most suitable for use where acids had to be dealt with in manufacturing processes.

An analogy had been drawn between the froth of soap and the froth of metals; it was said the froth cells were of the same shape as the crystal grains. He would follow this up. It reminded him of his cast-iron experiments. Was he right in assuming the idea to be that aluminium acted as a sort of vehicle for oxide which interposed between the crystals and caused brittleness? He was not quite clear about it. The question of gases had never been thoroughly investigated. Then there was the question of gas affecting crystallisation and cavity troubles. He had had experience of troubles through aluminium affecting a plumbago crucible. Was he right in assuming that aluminium had a very destructive effect upon an ordinary plumbago crucible? That had been his experience recently.

Mr. T. W. Markland asked whether the addition of a small quantity of aluminium to cast iron had the effect of weakening the crystals?

Aluminium Envelopes.

Mr. S. Smith said there were many points in the lecture which could be applied in the iron foundry. He had been interested in the froth experiment. From what Dr. Desch had said he gathered that the shape of the froth sud was practically the shape of the crystal, and that this applied to most metals.

He recalled the time, perhaps 40 years ago, when he had experience of the melting of aluminium. They had little squares or cubes of aluminium, out of which they made little things, and he noticed that it retained its position for a time while the melting went on, and then went all at once, as though the whole thing had been held together by an envelope, and as soon as that envelope went the aluminium was in a melted condition and ready for pouring.

Regarding fluidity, it might appear a simple question, but was hot water more fluid than cold water? He did not mean water at a temperature approaching freezing point but in the ordinary atmospheric temperature.

On the board Dr. Desch had drawn representations of grains with their boundaries, and he indicated that the centres were pulling away from the boundaries. Were those centres the first centres of solidification?

Then in a general way, he would put this question. Would brass or bronze develop cracks through vibration?

Properties of Alpha-Beta Brass.

Mr. L. W. Schuster said, as one of the members of the Manchester Metallurgical Society, he desired to express their appreciation of the courteous invitation to attend this meeting. He was afraid the main subject of the Paper was a little outside the sphere of his activities, but he had been much interested in the very interesting manner in which Dr. Desch had dealt with it, and he wished to mention one matter that occurred to him. That had reference to the question of the manganese bronze. Could the trouble which Dr. Desch had mentioned be minimised to an appreciable extent by a heat-treatment, which would remove the weakness and improve matters by recrystallising the metal? Usually when these metals failed they had very large crystal grains—beta crystals. He had not had many cases to deal with, but up to now he had never traced failure to internal stress; he had always found that the metal was highly oxidised, and contained an enormous number of cavities. The metal usually had aluminium in it, but he had never traced that that had been one of the causes of the trouble. Dr. Desch had suggested that the beta brasses be replaced by alpha-beta brasses. He would be glad to hear what sort of composition Dr. Desch suggested, and what physical properties such metal was likely to give.

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There was one other matter he wished to mention, referring to ordinary brass castings, so often used in places where they were subjected to corrosion. They got sound castings, but those castings had this wretched dendrite structure shown by one of the slides, and were in consequence heterogeneous and totally unsuited for resisting corrosion. It had occurred to him that by heat-treatment a more uniform composition could be got, the metal would have better physical properties, and would be more suitable for standing up to corrosion. He had been experimenting on those lines for some time now.

Mr. Hopwood asked whether the aluminium in any way formed nuclei on which the regular crystals formed, so that one got very regular grain values. Was the 10 per cent. aluminium an alpha-beta or purely alpha? He would suggest if it was all alpha or all beta it would have better chemical resisting properties.

Mr. Llewellyn said some time ago on examining under the microscope a bronze which had undergone heat treatment there were indications of gas inclusion. As it was heated in a gas muffle there was a possibility of gassing taking place. It was a homogeneous alpha structure. He had also examined phosphor bronzes from a CO_2 compressor. The acid had penetrated the bronze along the cog wheel.

AUTHOR'S REPLY.

Prof. Desch said that he did not profess to be able to answer questions relative to details of foundry workshop practice.

Mr. Primrose had remarked that large aluminium-bronze castings became brittle during self-annealing, when they were slowly cooled. He was not aware of that. When he was concerned with large castings the foundrymen used to fight very shy of 10 per cent. aluminium-bronze. It was a magnificent metal, but the shrinkage was so great, and there was so much trouble from inclusions, that after a few trials it was usually abandoned. Only in recent years had it become more common. So when he said he had not been able to get brittleness of the kind mentioned in 10 per cent. aluminium he was referring to small laboratory castings and would be very interested now to try whether the same thing applied to large slowly-cooled castings.

Aluminium oxidised readily and the aluminium oxide did not easily float up out of the metal. If tin bronze were being made and aluminium got into it there was formed a little film of aluminium oxide which destroyed the quality of the casting. The prejudice against aluminium in a foundry which was making other alloys was a perfectly legitimate one, and he was not surprised at it.

Mr. Sutcliffe asked many questions. He was not prepared to deal with foundry practice, and he had not attempted to follow the differences between foundry sands. He left that to his colleagues. With regard to the wetting of the sand, that was one of the reasons why he said it was necessary to know the surface tension of different metals. The wetting of the sand depended upon the surface tension of the metal in contact with it as well as on the oxide which was formed. There was no doubt that the surface tension of an alloy could be altered by adding a small quantity of another metal. That was one reason why they wanted to know surface tension, and work on that problem was being done in the National Physical Laboratory. Certain alloys possessed the power of wetting the surface of the sand, even when it was provided with facing materials. The question what particular material would have the effect of preventing wetting he must leave to someone else to deal with.

Fracture Test.

In brass and bronze the ordinary fracture test could be used by a skilled man with a good deal of accuracy, but it depended purely upon experience; no rule could be laid down for it. Indeed even the judging of pig-iron by fracture was becoming much less certain. Pig-iron used to be made in a much more regular fashion: there were now far more variations in manufacture than there were some years ago, and it was now very risky to judge pig-iron only by fracture. Every foundry should have access to a chemist if it could not have a chemist of its own. Brass and bronze were more variable metals than pig-iron, and he should say that judging by fracture was more unreliable with them than with pig-iron.

He was sorry he knew little about acid-resisting alloys. Nickel and chromium had the property of increasing acid resistance to a quite remarkable extent: it was possible to get high chromium alloys which were almost unattackable by anything that might be used, but he could not say much as to their practical use.

A question was asked about brittleness being caused by aluminium. In none of the cases that he had mentioned was the brittleness due to oxide of aluminium. All the metals were quite clean, free from oxide.

The use of aluminium in steel had to be very carefully controlled. Deoxidation could be brought about by a small quantity of aluminium. It must be kept down to a minimum and the steel must be put into proper condition before the aluminium was added. Aluminium oxide was formed as a waste product and, at the high temperature of steel, it came out in the form of an exceedingly hard particle. Those hard particles were responsible for many defects in cutlery, particularly where a high finish was required. They also caused machining difficulties. This was very well understood now by steel manufacturers.

Large Grained Chrome Steel.

Mr. Smith asked about a chrome steel that had unusually large grains. That kind of structure was only obtained by accident. Many of these steels in Sheffield were forged under the hammer, and sometimes they would break into a number of pieces. This was a piece which was in a state of brittleness, but he did not know quite the conditions which were required to bring it to that state of brittleness. In the ordinary forged steel those grains would be broken up. He had been told of an ingot of chrome steel made some years ago in Sheffield which had big grains like that. On being placed under the hammer it crumbled, all the grains came apart.

One question put by Mr. Smith was whether hot water was more fluid than cold. With one or two exceptions all liquids became more fluid as the temperature increased. In the case of water the difference was quite measurable. Sulphur on heating became much less fluid, in fact very stiff—a kind of treacle. But that was quite an exception. The centres of the crystals were centres of solidification, they grew outwards, and the boundary was determined by the surface tension.

Mr. Smith also asked whether vibration could produce brittleness. No, it would not produce brittleness. But suppose the metal were in a condition of internal stress: vibration might cause a distribution of the stress and the crack would be started.

Manganese Bronze.

Mr. Schuster had referred to the manganese bronze. There was no oxidation, only cracks in the metal, and when examined those cracks were found to be perfectly clean. A bar was cut and tested in the ordinary way and it broke, as any ordinary heat-treated metal would, right through the grains of metal. Where it had been overheated there was an inter-crystalline fracture.

Mr. Hopwood asked whether aluminium tended to cause the crystals to be more regular in shape. He did not think it did. The shape of the grains seemed to be very much the same in every case.

The question of gas in phosphor bronze needed much further investigation. Those who had followed the work of the Non-Ferrous Metals Research Association would know the very great improvement which could be brought about in most copper-alloys either by de-gasifying or by allowing them to solidify and heating and re-melting. He believed that before long they would see many foundries getting rid of gas in metal by blowing nitrogen through it. They did not look forward to ordinary foundries casting in vacuum, although it had been done in small laboratory experiments; when using a vacuum it was quite possible to get rid of the gases from most alloys. There were some foundries dealing with products of very high-tensile strength which were making castings under special conditions which were comparable with high-class forgings. The more that could be done the better it would be for the foundry industry.

A Seventeenth Century Casting.

Epigrams and paradoxes are always interesting and as regards the history of woolweights we have the paradox that though the whole subject of ancient woolweights has been cleared up very little is known about them! The explanation of the paradox is that Major Herbert Dent collected a mass of information which he recorded in 200 printed and handsomely illustrated copies, little known to the general public.

A fair number of these weights remain—perhaps about 50 in all. All follow roughly the same shape, that of the flat-iron used by laundry folk to-day; all are ornamented on one side with an embossed

A 7-lb. Wool Weight Cast in Bronze.
(By courtesy of the Director and Secretary, Victoria and Albert Museum, London, S.W.)

representation of the royal arms; all had a hole by which they could be carried; all were of bronze; all were about the size of the ordinary flat iron of to-day; and all are fairly represented by Fig. 1, for the photograph of which we are indebted to the Directors of the Victoria and Albert Museum.

The Statute of Edward III, dating 1650, referring to "wools and other merchandises" decrees that every stone of wool shall weigh 14 lbs. Major Dent, in his researches, has found that most of the weights remaining are of 7 lbs.; but some are of 14 lbs.

The weight illustrated is in the Victoria and Albert Museum, and its official description is as follows:—*Seven-Pound Wool-Weight* of the City of Peterborough. Bronze, cast, with the royal arms and initials I.R. English; 17th Century. H. 7 in.

This weight, like all ancient bronze work, is of a deep black colour.

The Story of Iron.—"The Story of Iron" is the title of a new educational cinema film just produced by the U.S. Bureau of Mines, in co-operation with three large iron companies. The film depicts in a popular way the processes involved in the mining and metallurgy of iron.

Training the Young Foundryman.*

By T. Makemson (General Secretary of the Institute of British Foundrymen).

Much that has been said and written about foundry apprenticeship appears to indicate that there is some confusion of thought with regard to the aim of the training. The training of the moulder has been confused with that of the foundry manager, and some writers appear to have no clear-cut ideas of the respective functions of practical and technical training. It is probably due to this confusion that so little real and lasting progress has been made.

Foundry workers are of two types, the workman, and the man holding a position of a supervisory nature. The kind of preparation required by the one type is not necessarily the same as that required by the other. The workman requires a practical training; the manager requires a much wider and more comprehensive outlook, which should, however, have a distinctly practical basis.

A system of foundry training should be aimed primarily at the training of thoroughly competent and intelligent workmen. It should also provide the necessary experience and advanced instruction to enable the more capable workman to prepare himself for promotion to the post of foreman and foundry manager.

It is desirable that the higher ranks of the foundry trade should be filled as far as possible by men who have come up from the lower ranks. There will, however, always be a number of men in the higher ranks who have entered from other sources. It is not within the scope of this Paper to deal with the training of the latter type of man.

The Training of the Future Workmen.

The apprenticeship of most of the skilled workmen of the present and past generations consisted of spending a given number of years in a foundry, receiving their instruction from the foreman or from the workmen with whom they came in contact. There was usually little system in the apprenticeship, but the foreman or workmen took a real interest in the apprentices, and it must be admitted that craftsmen of the very first order were produced.

Conditions have now changed, and the present day foreman has a multiplicity of duties which were unknown to his predecessor of a few years ago; he is, therefore, unable to give the necessary time and detailed thought to apprentice training. Modern conditions make it more difficult for the workmen to devote much of their time to helping and instructing the apprentices, much as they may be willing to do so. Furthermore, in all but the smallest foundries, there is more or less specialisation, and there is, therefore, less opportunity for the apprentice to obtain a varied experience. All these factors necessitate some definite system or scheme of practical training in the foundry.

The foundry worker of the past had little necessity for even the most elementary technical knowledge. It will, however, be admitted that the conditions in the trade are changing rapidly, and it is necessary for the workman of the future to be able to perform simple calculations, to read drawings, and to have some appreciation of the physical properties of the materials with which he has to work. These requirements necessitate some elementary technical education in adition to practical training in the foundry.

A scheme of training must therefore be two-fold—(*a*) practical, and (*b*) technical—and it should be definitely understood that the technical instruction is complementary to the practical and cannot supersede it to any great extent. It is true that the technically-trained apprentice will probably learn the practical work more rapidly, as he will be more intelligent and observant. There is no question, however, that the place to learn moulding is in the foundry and not in the school. The problem is to devise a scheme of training in the foundry which will produce a workman as capable as the workman of a generation ago who was trained by methods now obsolete.

There are two general schemes of systematic practical training, both of which are in operation in various foundries in this country, on the Continent and in the United States—(*a*) The apprentice spends the first two or three years of his apprenticeship in a "vestibule" shop or training shop before passing into the foundry; and (*b*) the complete apprenticeship is carried out in the ordinary foundry, but the apprentice spends the first two or three years under the close supervision of an instructor. These schemes will now be discussed in some detail.

The Vestibule or Special Training Shop.

This system has achieved some success on the Continent and in the United States, and one or two firms in this country operate similar systems. The shop is really a self-contained foundry, but is used entirely for training apprentices. In some training shops the apprentice works through a series of exercises, carefully graduated and designed to bring out certain features. At the end of a given time he commences to carry out work of a commercial character. Other firms eliminate the graduated exercises, or, at any rate, reduces the time spent on this kind of work, and the apprentice spends more of his time in the making of simple castings which would normally be made in the general foundry. Whatever may be the class of work on which the boy is engaged, he performs this work under the close supervision and under the instruction of instructors, and there appears to be little doubt that he does learn the elementary principles of the trade very rapidly, and that he quickly acquires a very fair degree of skill. The waste of time, which is very noticeable in the early years of most apprentices, is almost entirely eliminated.

The disadvantage of this scheme is that the instruction tends to be somewhat academic, and when the apprentice is transferred to the main foundry at the conclusion of his period in the training shop he finds that he has a certain number of things to "unlearn." Incidentally, some larger foundries have made very successful use of training shops for the short and intensive instruction of plate and machine moulders, but this application of the training shop is outside the scope of this Paper.

Supervised Instruction in the Foundry.

This is the more promising method, in that the boy learns to work on an economic basis from the very commencement of his apprenticeship, but he is definitely instructed how to do it, and he carries out his work under careful supervision of instructors. This method is really a modification of the old-fashioned apprenticeship, the difference being that the work of the instructor takes the place of the help which was previously given either by the foreman or the workmen when they had the time or the inclination. A period of two or three years is spent in this way. During the remainder of the apprenticeship, the boys are given an increasing amount of responsibility, and they carry out work either individually or in collaboration with the other apprentices or workmen. The instructors should still be available for advice and help, and it should be part of their duty to see that movements from one class of work to another are carried out as far as is consistent with the type of work done in the foundry with the state of trade.

This method appears to be the one which is most suitable for the foundries in this country. It can be applied, even in small shops, as it will be found that the supervision and instruction of a minimum of 8 to 10 boys are sufficient to employ the time of one instructor. In very small foundries, with only two or three apprentices it is impracticable to appoint an instructor, and it is suggested in cases like this that *the foreman should devote a certain amount of time to instructing the boys, or arrangements should be made whereby one of the workmen is specially appointed to carry out this duty.*

If it is understood that this workman devotes a prescribed period of time per day to this purpose, arrangements can be made to adjust the output of work expected from this workman, so as to take into consideration the time spent on instruction.

Whatever method of training is adopted, there must be a definite scheme, which should be drawn up only after the most careful thought. The scheme should give boys an opportunity to work as far as possible for some little time on every class of work carried out in the particular foundry, and there should be in existence a definite schedule which should show when the boy will pass from one type of work to the next. It should be the duty of the instructor to see that this schedule is kept as far as the state of trade in the shop permits, although naturally there will have to be some elasticity, as one can visualise a shop which at any given moment may be extremely busy in one department and may have absolutely no work in another section. It would be foolish to move the boys to the latter section from another, because his schedule says he should go there on a certain day. It is obviously desirable to let him stay in the old section for a short time until the new department is able to provide him with sufficient work to keep him busy.

Typical schedules of the apprentices' training are those which are operated by Metropolitan-Vickers Electrical Co., Ltd., of Manchester.

Technical Training.

The scheme of technical training should be directed to imparting the elementary technical knowledge which is necessary to enable an intelligent workman to understand the principles underlying the trade, but it should be sufficiently broad to form a basis for the more advanced instruction for those boys who are found capable of deriving benefit from it. In other words, technical training should be conducted with the moulder in view, but it should be broad enough to form a basis for the training of the future foundry manager.

The arrangement of a scheme of technical training necessitates consideration of several matters. It is necessary to decide whether the classes should be held in the day-time or in the evening; whether they should be conducted by the local education authority, or by the employer, and whether attendance should be voluntary or compulsory.

The ideal form of technical class is one held during the day-time by the local education authority, at which attendance is compulsory. Unfortunately, this ideal is very difficult to attain. The advantage of classes in the day-time is that the apprentice is fresh. The objection which has been frequently raised to day-time classes, namely, that work in the foundry would be interfered with, has been shown by experience to be groundless, as very little disorganisation takes place. Classes held by public authorities are recommended, because they make possible the attendance of apprentices from several works, and the larger numbers permit of the division of the classes into grades, elementary, intermediate and advanced, etc. Several firms are convinced of the advantages of day classes, and in default of the classes being provided by the local education authorities, are conducting the classes themselves in their own works and at their own expense.

The author realises that under present-day conditions the establishment of a number of day classes in various parts of the country is very difficult, as employers, as a whole, are not yet convinced of their advantages, and are concerned about the apparent disorganisation which they think takes place, and the expense of paying the employees' wages. At the present time, therefore, most employees have to be content with attendance at evening classes, and it is hoped that this Institute will arouse sufficient interest among employers and employees to induce a larger number of apprentices to attend the classes which already exist in many parts of the country, and also in-

* A Paper read before the Birmingham Branch of the Institute, Mr. F. G. Starr presiding.

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duce education authorities to establish other classes in addition to those in existence at present. It is perhaps hardly fair to enforce compulsory attendance at evening classes. The employer should, however, give encouragement to his apprentices to attend. Suggested methods of encouragement are the granting of time off on the evening of the classes without loss of wages, and a small reward for successes, either in the form of increased wages or a prize. The knowledge that success in evening classes will be taken into consideration in connection with promotion is perhaps the most valuable kind of encouragement.

Suggested Curriculum.

The following is a suggested scheme for classes in foundry work. This scheme is suitable for either day or evening classes, conducted either in schools managed by the local education authority or in works-schools managed by the employer:—(1) Revision of elementary school work in arithmetic, mensuration and general science; (2) elementary machine drawing and sketching. It is of much more importance that a foundryman should be able to make good sketches than is generally imagined. The fact that many excellent craftsmen do not possess this accomplishment is no reason why it should not be possessed by the next generation of foundrymen; (3) detailed lectures on the underlying principles of foundry practice, *i.e.*, runners, risers, venting, properties of sands and the many other practical details which have a scientific foundation which is too frequently misunderstood; and (4) *Foundry Metallurgy.* This should include some account of the manufacture of pig-iron, the influence of the constituents of iron upon its properties, and an elementary study of furnace design and cupola practice.

Pattern Makers.

The course to be followed by apprentice pattern makers included the following:—(1) Revision of elementary school work in arithmetic and physics; (2) drawing and sketching; (3) pattern-making materials; contraction; use of prints; loose pieces, drawbacks, etc.; methods of pattern construction: and (4) complete instruction in methods of constructing and laying out patterns and core-boxes for representative jobs. Making boards for loam moulding and patterns for plate moulding.

In all this work attention must be given to foundry requirements, and in considering any job the method of moulding the job should always be discussed. It is desirable to devote a few lessons to the purely metallurgical side of the foundry in order to widen the outlook of the apprentice.

Promotion Work.

It is essential to any scheme of practical and technical training that it should provide an opportunity for boys possessing more than average ability to qualify themselves for promotion to the higher ranks of the foundry trade. It is suggested that when boys reach a given age—say 19 or 20—the employer should endeavour to ascertain whether they are likely to be able to take advantage of more advanced training. At this age, most promising boys will have given some evidence of their promise. They should be selected for promotion on account of their practical knowledge and the ability which they have shown by their work in the foundry, and also on account of their technical work, which can be judged from the results of the school examinations.

Boys so selected should be given an opportunity of carrying out some more advanced work in the foundry. They should be given experience on the cupola and should also spend some little time in the testing and chemical laboratories and in the costing department. The details will, of course, depend upon the facilities existing in the particular works.

The technical training of the selected apprentices should consist of metallurgy, foundry engineering and foundry organisation. At present there is a considerable difficulty in acquiring advanced technical instruction suitable for the foundry industry, as it is only in a very few centres that such instruction is given and it is improbable that it will ever be possible to conduct advanced foundry classes in more than a few industrial centres. It is this difficulty which forms a very strong argument in favour of the establishment of some kind of foundry college or technical high school similar to the very successful school presided over in Paris by M. Ronceray. Whilst it is realised that there are some disadvantages in a college of this kind, yet there does seem to be room for the establishment of a modification of the French scheme, either as a separate college or as a department at one of the technical colleges or universities. It is probable that the latter suggestion is better than the establishment of a separate college.

Apportionment of Costs.

The degree to which the scheme is developed will depend to a large extent upon its cost and upon the possibility of receiving returns on the financial outlay in the direction of improvement in the personnel.

(*a*) *Practical Training.*—The cost of the practical training should undoubtedly be borne by the employer. The cost will be comprised principally of (*a*) the wages of the apprentice during the first part of his apprenticeship before he becomes of economic value to the employer and (*b*) the salaries of the instructors. It is well-known that the apprentice usually spends the first year or two of his apprenticeship in work which is definitely of an unproductive nature, and in many cases he barely earns his wages. An organised training scheme will have the effect of making the apprentice justify his wages at an earlier age and will, therefore, be a direct saving.

The second charge—that of the instructors' salaries, will undoubtedly be saved by the increased producing power of the apprentices working under his guidance. It can therefore be taken as practically certain that an organised scheme of practical training will actually be a paying proposition rather than a charge, on account of the increased productivity of the apprentices.

(*b*) *Technical Instruction.*—It is obviously the function of the local education authority to provide the technical classes in foundry practice. Complaint has frequently been made that the authorities are luke-warm and the small number of foundry classes which are held in various parts of the country are taken as a sign of the neglect. Undoubtedly, some education authorities are distinctly unhelpful, but the scarcity of foundry classes is probably due to lack of demand rather than to lack of enterprise on the part of the people responsible for their organisation.

A national training scheme in which technical training is an integral part will necessitate the extensive establishment of classes, and there is little doubt that when the education authorities are convinced that the demand exists, they will be willing to do all in their power to supply it. Many classes have died out through lack of support from the very people for whom they were intended. Training schemes will attract a better type of boy into the foundry, who will realise that the attendance of classes is a definite part of his training and there is little doubt, the classes will then come into existence.

In some parts of the country, foundry classes are being organised under the auspices of more or less informal advisory committees, which consist largely of members of this Institute. It is suggested that in every centre where such classes are found to be necessary, the members should themselves approach the local education authorities and if possible, act as local advisory committees.

An important feature is the type of man selected as teacher. It is not necessary to have a foundryman to teach drawing, mathematics, etc., but foundry practice, foundry organisation, etc., should certainly be taught by a man of wide foundry experience and advisory committees can help considerably in the selection of teachers.

Private Tuition.

There are several large firms in this country and in America who have organised their own trade classes at their own expense, thus avoiding the necessity of their apprentices attending the local technical classes. Such schools are usually held in the day time in the employer's works. The apprentice leaves his work for a prescribed number of hours per week and attends the classes. The whole of the expenses of such schools including the boys' wages while he is at school are borne by the employers. Most employers who operate such schools believe that the expense is justified as a business proposition. So convinced are they of the value of the elementary technical training to their apprentices that they organise it and pay for it themselves in default of suitable classes held under public auspices. The objection which is frequently urged—that attendance at the day schools interferes with the regular routine of the foundry—is found to be one which can be easily avoided by suitably arranged times of the classes. It is very often difficult for a boy to leave the foundry at a given time in the afternoon when casting is proceeding, but several foundries find it quite easy to release their boys for two or three hours per week in the mornings.

The financial responsibility for the advanced technical training naturally rests upon the governing body of the particular college at which the training is given. Government grants would be given, although there should be a large number of scholarships, some of which would probably be provided by the generosity of members of the industry. The governing body of the college arranging such courses would also expect, and would be entitled to expect, assistance from the industry in the provision of laboratory apparatus and equipment.

Financial Members.

The schemes of training, such as have been outlined, do undoubtedly impose financial responsibility upon the industry, and it is realised that the present time is a very difficult one financially. There is little doubt, however, that money spent on training the future personnel of the foundry should be treated in the nature of an investment. In times of normal trade there will be a definite shortage of skilled moulders, and even now there is undoubtedly a shortage of men trained on modern lines to fulfill the responsible positions. The gain to the industry will more than repay the cost in a few years' time.

It is found that some enlightened employers refuse to embark upon a training scheme because they fear that when once trained the apprentices will drift to the works of another employer, who will get the benefit of their training. This fear, whilst a perfectly natural one, is shown by experience to be groundless. Naturally, men who have completed their apprenticeship do pass along to other firms, but in very many cases they come back again to the original firm, and are all the better workmen for having had a little outside experience.

National Certificates.

A number of foundry classes are at present in successful operation in various parts of the country, and certificates are issued on the examination results. These certificates are granted by various provincial examination bodies, such as the Union of Lancashire and Cheshire Institutes. It has recently been pointed out in several quarters that there is no uniform standard for these certificates, and that a certificate granted in one district carries little weight in another. At present the examinations upon which these certificates are given deal with fairly elementary technical work, such as is found to be necessary to the intelligent moulder. The lack of a national certificate for work of this kind is perhaps not a serious disadvantage, as the moulder is generally judged by the work which he produces in the shop and not by some certificate which he holds. There is, however, a distinct need for some kind of foundry certificate of an advanced character suitable for the man who hopes to hold a position of responsibility in the trade. The holding of such a certificate will not guarantee that he will successfully manage a foundry any more than the holding of a medical diploma will guarantee that a man is successful in the treatment of disease. Success demands qualities of character in addition to knowledge, but it does demand the knowledge, and the certificate would be a guarantee that the holder possesses the requisite knowledge.

In the professions of mechanical, civil and electrical engineering, the national professional qualification is the associate membership of the respective institutions connected with those professions. A university degree in engineering

generally exempts the candidate from the associate membership examination. In other cases, the diploma of certain colleges exempt the candidate from certain portions of the examination, and require that he shall pass the examination of the respective institutions in certain sections only, before receiving his associate membership.

This consideration leads to the conclusion that sooner or later it will be the duty of this Institute to formulate and conduct some kind of examination. It will be impossible for many years to make membership of the Institute dependent upon passing such an examination, and such a course is not suggested. The existence of the examination would, however, increase the prestige of the Institute and of its members, and the examination certificate would be the national certificate in foundry practice.

The technical colleges would either prepare candidates for this certificate, or, alternatively, certain technical college examinations which reach a standard set by the Institute would exempt the candidate either from the whole or from part of the examination.

The whole question of apprenticeship has recently been referred to one of the Committees of the Institute to examine, and it is hoped that eventually recommendations will be made which will have a far-reaching effect upon training for the foundry industry.

Conclusions.

To summarise the proposals which have been made, it is recommended that a scheme of training should be devised on the following basis:—(1) Apprentices should be trained in the foundry under capable and experienced instructors appointed for the purpose; (2) that apprentices be encouraged to attend classes in elementary mathematics and drawing, and that local education authorities be encouraged to form classes in the rudiments of foundry metallurgy. Where it is found impossible to arrange such classes the formation of works classes conducted by the employer is recommended, and (3) selected apprentices should be given special training in the works and facilities to attend advanced classes.

It is realised that these proposals necessitate financial outlay, but there is little doubt that such outlay is justified and will be found to be a profitable investment. The present shortage of apprentices and the lack of facilities for training them properly are very serious problems. Any reasonable expenditure on proper training facilities is amply justified, and it can be taken as certain that when the training problem is solved boys will be attracted to the industry in greater numbers. When boys and their parents realise the opportunities that are present in the foundry industry, and when they realise that the boys will be properly trained to take advantage of these opportunities, then the shortage of suitable candidates for the foundry will be a thing of the past.

DISCUSSION.

The Branch-President (Mr. F. G. Starr) remarked that the great difficulty at present was to get the right type of boy; most of the boys wanted to enter the machne shop. There was also a difficulty in securing an instructor who was also a skilled craftsman able to exercise proper control. The problem of boys being allowed to attend school classes could, however, be overcome without much inconvenience in the foundry. Mr. Makemson had, he considered, given an outline which formed a good ground work to start on.

Dr. F. Johnson, of Birmingham Central Technical College, stated that the Birmingham Education Authority was anxious to do what it could to promote foundry training, and could not understand why the matter had not been taken up more energetically by the leaders of the industry. They could guarantee to provide all the technical instruction that was asked for, whether day time or evening classes were desired or both, provided a suitable scheme had the backing of the industry and a sufficient number of students was forthcoming. While compulsory attendance was satisfactory from an organisation and budgeting point of view, voluntary students were preferable, because they made the teaching more interesting and effective. However, compulsory attendance in the long run caused the students to desire an improvement in their status, and converted them to voluntary attendance at classes. A central college, as at Paris, was hardly the sort of thing to start with, though it might be an ideal for the future. Local efforts should first be made, leading up to a central body or college, where either a degree or national certificate could be obtained. The money required in different localities would not be large, as local authorities in large industrial centres already had the accommodation and could find the requisite staff. A local advisory committee was needed to set the ball rolling, and in Birmingham the Education Authority would be ready to co-operate with that committee. The observations and suggestions of Mr. Makemson showed him to be a man with a wide grasp of the difficulties involved, having an appreciation of the possibilities of the situation and a knowledge of the sporadic attempts already made to overcome the lack of facilities for the adequate training of foundry employees. He was glad to hear that the Institute was earnestly engaged in considering a scheme for the provision of greater facilities.

Apathetic Employers.

Dr. Fisher, Principal of the Wolverhampton Technical College, described Mr. Makemson's survey of the problem as admirable. He agreed that the right place to learn foundry work or fitting was in the shop. Nevertheless, all their experience indicated that it was desirable, and indeed necessary, inside their technical college to have workshop facilities of some kind, for without it there was no common ground between the teacher—no common ground to which the lecturer could refer—and the students drawn from diffenent places and doing different kinds of work. After all, it was not possible to experiment in a factory, and some provision was really needed for practical work in the college. He endorsed Dr. Johnson's view that local authorities were willing to provide the training required, and that the overhead expenses would be already met, as the necessary accommodation would be available. In Wolverhampton they carried on a foundry trades junior school which would have been closed down but for a recognition by the authorities of its importance; happily, it was now gradually growing, despite the apathy of employers. It was not a mere continuation school, and through a system of information and interviews, when boys left school more lads had been induced to enter for foundry work. These lads did experimental work with the materials of their industry directed to the problems of the foundry, and the instruction was designed to fit them for a senior course in the technical college.

An Experimental Foundry.

Mr. Flavell (West Bromwich) mentioned that the Principal of their Technical School had persuaded the Council to provide an experimental foundry. In the Midlands the apprenticeship of boys was not carried out sufficiently thoroughly. A condition of employment at his factory was that a boy should attend classes. He suggested that employers and heads of departments should try to understand the psychology of their boys. Boys wanted encouragement, and employers should interest themselves in the lads while they were at work. In order to get boys to use their brains it was a good thing to depart from stereotyped models and methods from time to time. The more interest employers took in their boys the better the class of lad they would get.

Mr. Rutland, speaking as Principal of the Engineering Department of the Wolverhampton College, in agreeing with Mr. Flavell, said no definite models were made at his classes. Every job was a job, and there was variety to interest the boys. There were no exercises as such.

Mr. Wilkinson (Birmingham) considered there should be no difficulty in obtaining suitable instructors. His own experience was that every one of the lads under training and on piece work earned his wages, and made more money for the firm than if the castings made had gone through in the ordinary way. "You can develop good craftsmen if you take an interest in the lads," said Mr. Wilkinson, in pointing out that the objection of some employers to giving such training—that young fellows would leave a firm after having received tution—cancelled itself, because young foundrymen in other works would also desire a change, and so the position would right itself. Further, if a new employer could afford to pay an increased wage, surely the old employer could do so. Nevertheless, it was undesirable for a young man to get into a rut, for obviously if he moved about he gained wider experience. If in the foundry they taught a lad to make castings well and quickly, and paid him for it, he would advance himself and become highly efficient; and if they could at the same time extend the facilities for technical training, by all means do so. The lack of skilled men was because boys were "put in a corner," and consequently had to pick up knowledge of their work anyhow. A capable young man who would have a natural sympathy with lads should be placed in charge of them; they should be provided with different kinds of work from time to time; and, given encouragement, he ventured to say that they would make good progress. The solution of the trouble in the foundries lay in their own hands; they only had to take a moderate amount of care and interest in the training of these boys, and believed from his own experience that they would respond.

Lessons from Wasters.

Professor Hanson (Birmingham University) thought there was a need for small foundries at technical colleges where they could practice in a small way some of the things done in industry, but not with the object of making castings. The real reason was so that the students could see what happened when the metal melted and solidified. As a previous speaker had said, the students learnt a lot more when a bad casting was made, because the faults could be pointed out and the causes investigated. Such facilities enabled the teacher to give instruction on what to avoid and how to avoid it, and to explain the cause of faults and so forth.

Mr. Greenway, speaking as one who had gone through his apprenticeship, made several suggestions, and in commenting on pattern making urged that it was necessary to obtain an inside knowledge of machine moulding.

In reply, Mr. Makemson said that present facilities were scattered, and some co-ordination was required to get the boys into actual touch with these various schemes. He agreed that the problem lay more inside the foundry than with the technical school. His own experience of training apprentices was that it was a paying proposition. Boys wanted to do something useful. Odd jobs and errands took away their enthusiasm, which they ought to encourage. A foundry in the technical school was not essential perhaps, but it was extremely useful for pointing out defects. Every scheme of training should be definitely practical and have a commercial aspect.

Machine Tool Trade Association.

The annual dinner of the Machine Tool Trade Association was held in London, Sir Alfred Herbert, the president, ocupying the chair. Mr. H. Butler, the vice-president, proposed the toast of "The Engineering Industry." He said that this country was the birthplace of engineering and our reputation was one of excellence. The country must not allow itself to be side-tracked into the production of cheap machinery. Since the war Continental business had shown a shrinkage. That was because Continental customers had been too poor to buy. The first signs of improving business were increased orders from Continental customers. The country was not backward in shipbuilding, bridge building, motors, or even typewriters or gramophones; and certainly not in machine tools. Sir Arthur Balfour, proposing "The Association," said that one of our troubles in this country was that we were a little too modest about what we could do.

Fourth Machine Tool and Engineering Exhibition.

The Exhibition Secretary (70, Victoria Street, Westminster, S.W.1) informs us that practically the whole of the ground floor has been let and about one-half of the gallery. The amount of space already let is 50 per cent. more than the whole amount of space let at the 1924 exhibition.

XUM

Foundry Purchasing.—XXIV.

By Eric N. Simons.

Comparing Quotations.

For certain classes of goods the comparison of quotations is so difficult and complex a matter that mere price-figures are insufficient to enable a decision to be reached. Other factors, such as design, delivery date, the reputation of the supplier, the total weight of material covered by the quotation (an important matter when complete plants are being quoted for), and so forth, may all enter into it. Any verbal explanation of the differences of this sort between the respective suppliers—say, to a board of directors or to a group of works managers—may involve the buyer in innumerable repetitions and re-statements. It is better, in such instances, to have a proper means of systematic comparison. This is obtained by use of a quotation comparison sheet, such as that shown in Figs. 1 and 2. This enables the buyer, or whoever he has to consult, to see at a glance the result of the inquiries, and to compare in an orderly way the merits of the different offers.

In comparing quotations, every care must be taken to see that all the relevant factors are taken into account. In certain instances the supplier may, on his own initiative, put forward alternative suggestions, which should never be ignored, as in them may lie the possibility of great economies. Assuming all these secondary factors to be equal, and the goods offered to be of known good quality, price should be the determining consideration in placing the order.

COTTON WASTE.

Supplier.	Price.	Payment.	Delivery.	Previous Record.	Remarks.

Fig. 1.—Form for Comparing Quotations.

	A.	B.	C.	Etc.
Name of firm tendering				
Date of tender				
Machine				
Speed revolutions per minute				
H.P. required				
Output per hour				
H.P. per ton of output per hour				
Weight				
Price				
Price per ton				
Special remarks				

Fig. 2.—Another Type of Form for Comparing Quotations.

When Order-Placing is Complicated.

It does not always follow, however, that the quotations submitted leave the issue clear-cut. In fact, from a long experience of quotations, the writer would assert that an astonishing phenomenon in business is the way in which relevant details contrive to get themselves omitted from quotations. The buyer may have to begin a series of protracted negotiations with the supplier whose quotation he favours. He may wish for certain doubtful points to be cleared up, or he may have an idea that by skilful bargaining he can obtain a better offer. He may also have to arrange deliveries to coincide with his anticipated needs. As a general rule, negotiations of this kind are only necessary for orders of importance.

If official letters of inquiry have been sent out to a number of firms, it is only courteous and fair to send an official notification that the quotation has been unsuccessful in securing the order. It is too often overlooked by buyers that some inquiries necessitate an enormous amount of hard work by estimating departments, involving the preparation, in certain instances, of detailed drawings and tracings, the preparation of samples, innumerable calculations, and so forth. To allow all this work to be done without even the reward of a formal notification of its success or failure is unjust and unreasonable. Furthermore, the absence of any such indication puts the supplier to the necessity either of sending his representative to inquire into matters or of writing letters or making telephone calls to find out what has happened. It exposes the buyer to those needless interrogations, and, in short, causes far more work than the discourtesy saves.

If all the procedure outlined thus far has been carefully observed, the buyer will find himself able to place the order, with the knowledge that it is well placed. He will, as a result of his records of supply sources, know that those who have quoted are the most likely people, and that the firm finally chosen has reached its position as the result of a process of careful choice. He will know that he is getting good materials at an economical price from reputable people. He will know that he has provided all the information needful for the proper execution of the order; that he has made all necessary arrangements to ensure delivery at the appropriate times and in the appropriate quantities; and that he has fixed up terms of payment as good as he could obtain.

ORDER FORM.

No. P/C/34519.

JOHN SMITH & COMPANY, LIMITED.

Royal Iron Works, Stafford.

Telephone: 1439 Central Telegrams: Smith, Stafford.

To.....

Conditions.

Invoice and advice note in duplicate bearing above order number must be sent when goods are despatched. A separate invoice must be sent with each order. Statements of accounts for each month's invoices must be tendered by the 10th of the following month. Monthly accounts are paid on last day of month following delivery. Material to be sent carriage paid unless otherwise stated.

To be delivered.....
Time of delivery .....

For John Smith & Company, Limited.
(*Signed*).....

Fig. 3.—Typical Order Form.

The Work of Ordering.

Hitherto, it must be borne in mind, the buying department has been concerned with internal matters—the requisition, the checking of the requisition, the obtaining of prices, the comparison and discussion of offers, and the final decision. With the entry of the order upon the scene, external affairs begin to play their part. The difference between orders and requisitions is that the former involve serious obligations towards an outside organisation, whereas the latter are purely domestic, and have no legal significance. This point must be continually remembered.

The order form itself is one of the most important things, since omissions from this may involve the buying department in endless confusion and trouble. It is fairly safe to say that no two firms have exactly similar order forms. Figs. 3 and 4 show representative examples. Nevertheless, to some extent their requirements are identical.

Telegrams: .....
Telephone: .....

ORDER.

Reference.....
It is ESSENTIAL that correspondence, advices, and invoices respecting this order bear this reference in full.

Form 0/1/1.

Reqn. No.	Job. No.	*Please supply carriage prepaid to* ..... (*for rail address see back*)
Checked.		This Order is Placed on the Following Conditions :— *Invoices, advices and statements must be rendered as per instructions on the back hereof. For short weight, loss, or breakage in transit we will* not be responsible, *but provided the conditions printed hereon are complied with, we undertake to advise senders and carriers on arrival. Payment made in cash as above on the last day of the month following delivery at our works. Packages must be supplied free, but will be returned on request at suppliers' expense.*

On back are lists of works' addresses with railway instructions re consignment, and also instructions for forwarding of invoices, advice notes and statements.

Fig. 4.—Typical Order Form Issued by Central Buying Office of Firm with Works in Different Towns.

BLACKING,
PLUMBAGO,
CORE GUM,
WHITE DUST,
COAL DUST.

ESTABLISHED 1863.

JAS. DURRANS & SONS, LTD.
PHOENIX WORKS, PENISTONE, near SHEFFIELD.

Telephone:
21 PENISTONE.

Telegrams:
"DURRANS, PENISTONE."

Manufacturers of
FOUNDRY EQUIPMENTS

LADLES,
FIRE BRICKS,
STONE FLUX,
CASTING CLEANERS,
PIPE NAILS,
SPRIGS,
WIRE BRUSHES,
BELLOWS,
CUPOLAS,
GANISTER,
LOAM AND SAND MILLS,
STUDS,
CHAPLETS,
BRUSHES,
CORE ROPES,
BUCKETS,
SPADES, Etc.

Write for Illustrated Catalogue on Blacking and Foundry Requisites, also for our latest Price List.

TEAM BY-PRODUCT COKE CO., LTD.
DUNSTON-on-TYNE
"TEAM" PATENT COKE
SPECIAL FOUNDRY QUALITY

FOR PRICE AND PARTICULARS APPLY TO:—
ALEXANDER LEITH & CO.,
25, COLLINGWOOD STREET,
NEWCASTLE-ON-TYNE.

TYPICAL ANALYSIS (If necessary guaranteed)

ASH	not exceeding	8%
SULPHUR	,, ,,	0·8%
VOLATILE	,, ,,	1 %
MOISTURE	under	1·50%

GANISTER, CUPOLA BLOCKS, FIRE BRICKS,
FIRE CLAY.
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.
STEEL MOULDERS' COMPOSITION, SILICA CEMENT.

J. GRAYSON LOWOOD & CO., LTD.
DEEPCAR, nr. SHEFFIELD.
Telegrams: "LOWOOD, DEEPCAR."

Trade Talk.

Messrs. W. Hipkins and C. T. Hipkins, iron merchants, Stafford Street, Birmingham, trading under the style of Hubert Whitfield & Company, have dissolved partnership. Mr. C. T. Hipkins will continue the business.

The Scheldt Intercommunal Electricity Company, of Antwerp, have placed an order with Ateliers de Constructions Electriques de Charleroi (A.C.E.C.) for two 40,000 k.v.a. 10,500 volt 50 cycle 3-phase 3,000 r.p.m. turbo-alternators.

The Pont-a-Mousson Cast-Iron Pipe Foundries have just obtained another contract for 2,500 tons of cast-iron pipes for the City of Vienna (Austria) against the competition of the combined Association of the German, Hungarian and Czecho-Slovakian foundries.

Mr. W. T. Dunn, secretary of the Institution of Gas Engineers, 28, Grosvenor Gardens, Westminster, S.W.1, has issued a copy of the Petition, Charter and By-Laws which was submitted at the special meeting of the Institution held on April 2, under the chairmanship of Mr. H. D. Madden.

The Standing Committee appointed by the Board of Trade have reported on their inquiry as to whether imported enamel zinc sheets should be required to bear an indication of origin. The Report is obtainable from the Stationery Office at a cost of 2d. Certain marks are recommended.

The members of the British-Acetylene and Welding Association met at the Old Colony Club, 84, Leadenhall Street, E.C.3, on Thursday last, when a paper entitled "The Welding of Stainless Materials," by Messrs. H. Bull and L. Johnson (of Brown Bayley's Steelworks, Limited, Sheffield), was read and discussed.

Mr. H. G. Blakemore, owing to expansion of business, has transferred his offices from 180, Piccadilly, W.1, to Windsor House, Victoria Street, S.W.1. In addition to the sale of contractors' plant in general, Mr. Blakemore is the London representative of Alexander Wilson (Aberdeen), Limited, Alex. Laurie & Sons (Falkirk), and the West Bromwich Casement & Engineering Company, Limited.

The Port of London Authority announce that a very substantial reduction in the rates on exports shipped over the authority's dock quays will take effect as from May 1. This concession will be made to assist trade generally and to encourage the shipment of goods over the London quays. The tariff schedule is now in course of revision, and will be simplified by the reduction of the classifications from twenty to twelve.

The statutory annual meeting of the British Electrical and Allied Manufacturers' Association took place at 36 Kingsway, W.C.2, on Thursday, March 15, Colonel R. K. Morcom, chairman of the council, in the chair. The business at the meeting was of the usual formal character, and included the presentation of the accounts and annual report, the election of members of council and of auditors. At the subsequent meeting of the council Colonel Morcom was re-elected chairman for the new session.

A resolution in favour of the safeguarding of steel was carried at a meeting attended by more than 80 Conservative M.P.s at the House on Thursday, March 22. Representatives of the steel trade and the consumers of steel and tinplates made a statement of their case, and subsequently Sir Henry Page Croft, M.P., moved the resolution, which set forth that the meeting viewed with grave and increasing concern the progressive depression under which iron, coal, and steel industries are suffering, involving serious possibilities of permanent contraction in those industries. The resolution will be communicated to the Prime Minister and the President of the Board of Trade.

The Royal Metal Trades' Pension and Benevolent Society held their 67th annual dance at the Hotel Cecil on Friday, March 23. Among those present were many well-known members of the metal and allied trades, and in all about 364 tickets were taken at the door. The dance was the chief attraction of the evening, but at the interval supper was taken, Mr. Edgar E. Starke being in the chair. The chairman proposed the toasts of "The King" and "The Royal Metal Trades' Pension and Benevolent Society, mentioning receipt of a letter from the chairman of the board of management, Mr. A. K. Stevens, who is holding this position for the eighth year in succession, calling attention to the fact that speeches were to be limited in duration. Mr. Starke said he would not worry those present with figures and statistics, as everyone knew the aims and purposes of the Society. Other toasts included, "The President," Capt. O'Brien, and "The Chairman," Mr. Edgar E. Starke.

In connection with the contract placed by Imperial Chemical Industries, Limited, with the Metropolitan-Vickers Electrical Company, Limited, for steam turbines with generators and condensing plant, it is stated that the feed heating turbines are designed for operating with superheated steam at a pressure of 260 lbs. sq. in. gauge, and exhausting at a pressure a little below atmospheric. The exhaust steam from these turbines will be led partly to the first stage feed-heaters, and the remainder to the evaporating equipment which is being supplied under another contract. Three tapping points will be provided at the turbines from which steam is bled to the second, third and fourth stage feed-heaters, the fifth stage being, as already mentioned, fed direct from the receivers into which the primary turbines exhaust. The feed-water heaters will be of the surface type, vertical pattern, fitted with float-controlled automatic by-passes. Three sets of boiler feed pumps will be supplied, each equipment consisting of a low-pressure and an intermediate-pressure pump coupled together and driven by a motor, and a separate motor driven high-pressure pump, a fourth boiler feed pump with a single feed water heater forming a standby. There will be three sets of heater drain pumps, comprising the necessary motor driven extraction and lift pumps for removing the condensed heating steam from the heaters, each pump discharging into the boiler feed main after the heater which it serves. The whole of the pumps will be supplied by Mather & Platt, Limited, as sub-contractors. The considerable use of steam directly applied to chemical processes makes it necessary that the capacity of the evaporating equipment providing the necessary boiler feed make-up should be much greater than is usual with ordinary turbo plant. The whole of the make-up, together with the condensed steam returned from the various portions of the works plant, will be treated in de-aerators (not included in this contract) and thence pumped through the feed water heaters in which the temperature will be raised to about 400 deg. Fah. The condensing turbines will utilise the remainder of the steam exhausted by the primary turbines and are intended to act as equalisers for the system. The conditions of service do not permit of fluctuations of load being carried by either the primary or the feed heating turbines. All fluctuations in requirements of steam or electrical output, or of both together, will therefore be carried by the condensing turbo-alternator sets. Under the normal operating conditions of the plant the service rating of the condensing sets will be about 8,000-kw., but each set will be capable of carrying 12,500-kw. continuously, the alternators being duplicates of those for the primary turbo sets. The alternators will be of standard Metrovick design. The six larger units will have a capacity of 15,625-kva., and the three smaller units a capacity of 7,500-kva. All the machines will be arranged for ventilation on the Metrovick patent closed-circuit air-cooling system.

Personal.

Mr. H. Sutcliffe has been appointed to take charge of the Manchester branch of Shanks & Company, Limited, in place of the late Mr. Andrew Shanks.

Mr. H. L. Brackenbury, who has retired, was a well-known North Country engineer, and for 33 years was works manager at the Elswick Works of Sir W. G. Armstrong, Whitworth & Company, Limited, and eight years managing director of Parsons Works.

Sir Alfred Mond, M.P., has been awarded the Gold Medal of the Institution of Mining and Metallurgy "in recognition of his scientific and industrial services in the development of the mineral resources and metallurgical industries of the British Empire."

Mr. Robert Hoxon, who has retired after 64 years' service with Robert Stephenson & Company, Limited, has been presented with a cheque by Mr. J. N. Goodall, managing director, on behalf of the firm, and a wallet of Treasury notes by Mr. J. L. Taylor on behalf of the workmen.

Mr. R. D. Moore, B.Sc., has been re-elected president of the Institution of Engineers and Shipbuilders in Scotland for the next session. For sessions 1928-31 the following were elected vice-presidents:—Mr. John Anderson, Professor J. D. Cormack, Mr. Arch. Gilchrist, and Mr. W. H. Riddlesworth. Vacancies in the Council were filled by the appointment of Messrs. A. P. Cole, N. O. Fulton, S. J. Pigott, S. B. Ralston, J. A. Warren, A. Scott Younger, and (Associate) Fred. C. Stewart.

Wills.

Jackman, J., of 19, Grange Crescent Road, Sheffield, a director of Joseph Jackman & Company, Limited, of Persberg Steel Works, Sheffield £6,528

Hornung, T., 4, Durward House, Kensington Court, W., formerly a leading iron merchant in Middlesbrough £34,876

Wright, Col. Charles Henry, of Tillington Hall, Stafford £29,623

Contracts Open.

Glasgow, June 4.—The Trustees of the Clyde Navigation require construction and erection of an electric cantilever crane, of 175 tons, 150 tons or 130 tons lifting capacity. Mr. D. Fife, mechanical engineer, 16, Robertson Street, Glasgow. (Fee £3 3s., returnable.)

London, E.C.1, April 20.—Iron and steel, bolts and nuts, iron, brass, gunmetal and other castings, etc., for the Metropolitan Water Board. The Chief Engineer, 173, Rosebery Avenue, E.C.1.

London, S.E.—The India Store Department, Belvedere Road, Lambeth, S.E.1, require:—(1) Motor generator sets and switchgear; (2) 20 nautical miles muscat cable; (3) 149 rolls wire fabric for reinforced concrete; (4) hematite, West Cumberland (1,000 tons 0.025 S. and P., 500 tons 0.020 S. and P.); (5) 690 tons of bridgework. (Fee 5s. each schedule, non-returnable.) Tenders on April 11 for (1), April 13 for (2), (3) and (4), and May 4 for (5).

London, W., April 12.—Stores, for the Great Western Railway:—Electrical wires and cables, tinplates, tinware, wire, iron and steel, nails, screws, copper and zinc nails, etc., eaves, gutter and stack pipe, sheet iron goods, etc. The Stores Superintendent, Swindon.

Manchester, April 12.—The Corporation require iron and steel and tool steel. Mr. H. C. Lamb, chief engineer and manager, Electricity Department, Town Hall, Manchester.

Reports and Dividends.

Bede Metal and Chemical Company, Limited.—Profit, £14,611; dividend, 5d. per share, less tax; replacements, etc., in works, £6,000; carry forward, £4,976.

Lancashire Dynamo and Motor Company, Limited.—Depreciation, £7,319; debenture interest, £2,157; profit, £19,726; brought in, £4,127; dividend, 5 per cent. on ordinary shares, less tax; reserve for directors' fees, £700; reserve account, £5,000; carry forward, £5,350.

Stewarts & Lloyds, Limited.—Profit, £615,742; depreciation, £175,000; brought forward, £105,566; available, £546,308; dividends on preference and preferred ordinary, £94,400; reserve, £175,000; dividend, 1s. per share, less tax, on deferred shares for year; carried forward, £114,724.

British Aluminium Company, Limited.—Profit, £432,176; taxation and proportion of profits payable to directors, £49,584; service of debenture debt, £103,224; reserve for depreciation, £50,000; reserve account, £100,000; staff benefit fund, £10,000; dividend for year on ordinary shares, 10 per cent.; balance carried forward, £27,858.

Continental Steel Trust.

Reports have been circulated in the German papers from Paris alleging in particular that French steelmakers are dissatisfied with the Continental Steel Trust, and with these have been associated rumours of an impending dissolution of the Trust. If these reports are to be taken seriously, German interested circles assume that the Polish demands for admission to the Trust are responsible for these rumours, and also the dissatisfaction of the Czechs. Two of the leading works in Czecho-Slovakia—the Poldi Hütte and the Skoda Works—are reported to have already severed their connection with the Trust. But the dissolution of the Trust is at present scarcely possible legally. Three months' notice to determine the agreement can formally only be given on July 1, 1929, and before that date dissolution can only take place by a unanimous decision.

On the other hand, since the existence of the Trust it has been sufficiently emphasised in German circles that German industry has had to make great sacrifices, as the division of the quotas turned out to be very unfavourable to Germany. Although in recent months the prejudice to Germany has been somewhat mitigated through the reduction in the penalty to $1 per ton, the feeling in German circles is general concerning the failure to form selling syndicates for various products, so that France would consequently not stand alone in being dissatisfied. As reported last week, Germany's export quota has been raised by 50,000 tons per month.

Gwynnes, Limited, 8, Victoria Street, Westminster, S.W., are paying a dividend to preferential creditors. The last day for receiving proofs is April 10.

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Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—With the near approach of the Easter holidays the volume of business transacted in the Cleveland iron market has been on a diminished scale, with, however, a hopeful prospect of a revival of active buying as the season advances. Most of the principal ironmasters are already well booked forward with contracts for home consumers, while on the export side there has been a rumoured inquiry for 10,000 tons of Cleveland iron for shipment to Antwerp and that the order had been secured. Careful investigation discredits the story, but the fact that it was accepted with reserve indicates that at present prices there is nothing wildly improbable in the report. The return of the Tees export trade for March reveals a steady improvement in tonnage, and it is clear that Cleveland is gradually recovering its competitive power. From this area foreign iron is now completely excluded. Meantime uniform prices are quoted to both home and foreign buyers as follows: No. 1 Cleveland foundry iron, 68s. 6d.; No. 3 Cleveland G.M.B., 66s.; No. 4 foundry, 65s.; No. 4 forge, 64s. 6d.

The recent increased activity at the steel works is reflected in a rather better demand for hematite, and with reduced outputs at Tees-side has opened up the prospect of an early liquidation of excessive stocks at makers' works. For the present prices remain stationary at previous levels, with mixed numbers of East Coast quality still quoted at 70s. and No. 1 70s. 6d. per ton. On the North-West Coast, Bessemer mixed numbers are firm at 70s. per ton.

LANCASHIRE.—Business in the local markets for foundry pig continues quiet, both inquiries and actual orders during the current week being relatively few in number. A rather depressing influence, so far as current bookings are concerned, is the fact that stock-taking is in progress at a number of foundries, and there is, in consequence, no disposition to add to stocks for the time being. Quotations, however, remain steady as follows: Derbyshire No. 3 foundry, 72s. to 72s. 6d.; Staffordshire, 71s. 6d.; Cleveland, 79s., and Scotch 87s. 6d. to 90s. per ton, all delivered Manchester or equal.

THE MIDLANDS.—Demand for all grades of foundry pig in this district continues quiet and uneventful, little iron being booked at the moment for forward delivery, the ironfounders, generally speaking, buying small quantities from hand to mouth. They themselves are by no means busy, and meagre stocks of foundry iron at the iron foundries are general. Prices remain unchanged about as follows: Northants No. 3, 58s. 6d. to 59s.; Derbyshire No. 3, 63s. 6d. to 64s. 6d.; North Staffordshire, 63s. 6d. to 64s. 6d., all f.o.t. furnaces. Scotch No. 3 about 90s. per ton delivered. Lincolnshire No. 3 and Cleveland No. 3 iron are 72s. 6d. and 81s. 9d. respectively, delivered Birmingham district.

SCOTLAND.—Consumers of foundry pig in this area are still using foreign iron, but now find Cleveland quality cheaper, and consequently, as contracts with Continental sellers are completed, they are not being renewed. Cleveland is, in fact, getting the reversion of this business, and the big orders recently booked in Glasgow are reflected in the jump in the shipments to Grangemouth. Prices of Scotch No. 3 are now quoted 70s. per ton at furnace.

Finished Iron.

Manufacturers of this class of material report little improvement in the general state of business, and in the Midlands, more especially, there is keen competition for any orders in circulation. Staffordshire marked bars are unchanged at £12 10s. at works. The mills making this class of iron continue to be fairly well engaged. In Lancashire crown bars are still being offered at the Association price of £10 per ton, and seconds at £9 10s., both delivered. For merchant parcels of the former, quotations are still on the basis of 14s. per cwt., less 2½ per cent., and including delivery to buyers' works.

Steel.

The position in the steel industry continues disappointing, some of the British works being still poorly off for orders, and as a result competition is keen for any business that is passing. On the other hand, buyers are content for the time being to watch the market, and reports from most of the export agents indicate that consumers abroad seem to have covered their requirements. At Sheffield, although there is a marked reduction in Continental competition, the market shows very little, if any, increase of activity; indeed, conditions have been slower lately than for some time. Business in soft basic billets, however, is better, and production is being expanded. Acid steel billets are quiet. There is a growing demand for railway steel for export, and makers of special steels are very busy. Quotations:—Siemens acid billets, £10 per ton; hard basic billets, £7 2s. 6d. to £7 12s. 6d.; soft, £6 5s.; soft wire rods, £7 10s.; steel hoops, £9 10s. to £10 10s. In the tinplate market prices are firmer all round, and it is now difficult to place new business at under 18s. basis. Most works are now fully booked to present capacity for at least a couple of months, and transactions reported lately include lines for shipment running into the fourth quarter of the year.

Scrap.

Reports from the various centres of the scrap metal trades again vary widely as to the state of business and prices current, but, on the whole, it may be said that conditions are very little changed in any of the leading foundry lines. In the Midlands there is a good demand for cast-iron scrap, particularly the heavier qualities. Apparently, however, there is more available than has been the case recently, and this has had the effect of somewhat easing prices. The foundries state that they are able to obtain the whole of their requirements of heavy machinery scrap in cupola sizes at 67s. 6d. per ton delivered, and light cast-iron scrap at 53s. per ton delivered. In Scotland machinery cast-iron scrap is unchanged at 70s. per ton, and for heavy ordinary, suitable for foundries, 65s. per ton. For old cast-iron railway chairs the price is now around 67s. 6d. to 68s. 6d. per ton. Heavy cast-iron scrap suitable for steelworks is 65s. per ton, and light cast-iron scrap 60s. per ton. The above prices are all per ton delivered f.o.t. consumers' works.

Metals.

Copper.—Movements in most sections of the markets for base metals have indicated in a general sense a steadier tendency, a feature suggesting an increase of interest on the part of non-speculative buyers, especially noted in the case of warrant copper values. Quotations for cash, however, are unchanged from the previous week's close, and only a moderate tonnage has been disposed of daily. The American domestic market has shown an improved tone, but the considerable production of casting copper at the present time is a noticeable and somewhat new feature in the general situation.

Official closing prices:—

Cash.—Thursday, £61 16s. 3d. to £61 17s. 6d.; Friday, £61 18s. 9d. to £62; Monday, £61 18s. 9d. to £62; Tuesday, £61 17s. 6d. to £61 18s. 9d.

Three Months.—Thursday, £61 18s. 9d. to £62; Friday, £62 to £62 1s. 3d.; Monday, £61 18s. 9d. to £62; Tuesday, £61 17s. 6d. to £61 18s. 9d.

Tin.—The market for standard tin continues quietly improving in tendency, and, though without sensational price movements, gives little indication of reactionary developments in the immediate future. Prices recently were lower, chiefly on account of weakness in America and some selling pressure in the Eastern markets, and this gave an opportunity to the professional element to depress the market. Subsequently, however, large buying orders came on the market on American account for Straits tin, which made for a good recovery.

Official closing prices:—

Cash.—Thursday, £238 10s. to £238 15s.; Friday, £239 to £239 2s. 6d.; Monday, £241 to £241 5s.; Tuesday, £239 15s. to £240.

Three Months.—Thursday, £238 2s. 6d. to £238 5s.; Friday, £238 to £238 5s.; Monday, £239 15s. to £240; Tuesday, £239 10s. to £239 12s. 6d.

Spelter.—Dealing with conditions in ordinary spelter, Henry Gardner & Company, Limited, write:—The market has fluctuated between narrow margins, and dealings on 'Change have been largely professional. Consumers have remained out of the market, and there is a dearth of inquiry from the galvanising trade. The Continent is quiet, and offering of spelter from that quarter very restricted. The American market is firm, and there is no spelter available for export.

Official closing prices:—

Ordinary.—Thursday, £25 1s. 3d.; Friday, £25; Monday, £24 18s. 9d.; Tuesday, £24 18s. 9d.

Lead.—In regard to soft foreign pig, consumers having bought more freely has helped the market a good deal, but the close was easier at well under the best, and there is an ample supply coming forward this month, so that there is no particular justification for any material advance just yet.

Official closing prices:—

Soft Foreign (Prompt).—Thursday, £20 2s. 6d.; Friday, £20 3s. 9d.; Monday, £20 3s. 9d.; Tuesday, £20 5s.

Portable Foundry and Patternshop Machines.

At a recent meeting of the Institution of Electrical Engineers it was pointed out that the term portable is applied loosely nowadays, but usually implies that the appliance can be transported from place to place more or less rapidly by pushing, pulling, towing, or even carting in a lorry, and is not necessarily suitable for picking up by hand; but portable machines for patternshop and foundry are in nearly all cases machines that are so light that they can be carried about and operated by one man. The extreme lightness of their construction and the small space which they occupy have made portable machines available for much of the work formerly done by hand in engineering workshops, and this remark applies also, but not to the same extent, to patternshops and foundries.

The electric screwdriver is not, and never will be, a patternmaker's tool, but a portable drill which would do much of the boring that is commonly done by the brace would be an invaluable tool. Some of the most useful portable pattern-making machines are seldom or never seen. It is possible now to get an electric shaper which is very suitable for rounding corners up to 7/16 in. radius, and also for making concave cuts. This small device is operated by a small motor and runs from the lighting circuit. A unique feature of this shaper is a cooling device which keeps the motor cool at all times and makes it possible for the operator to hold the machine in his hand. It is rather surprising that the small bench planing machine has not become more popular. Small machines with a motor drive are exceptionally useful to supplement the use of the big machines. Short lengths of timber can be faced and edged on those machines with greater safety and in quicker time than on the ordinary large machines, and are invaluable in all classes of patternshops. Then there are bench trimmers, the most usual of patternshop portable machines. These save a great deal of labour, especially when building segmental work.

The portable electric hand saw will rip and cross cut or channel hard wood up to a thickness of 3¾ in. at the rate of 5 ft. and upwards per minute, the power being derived from a ¼ h.p. universal motor. Other portable woodworking tools of great importance are electric sanders. The electric hand saw ought to be a useful tool in the timber shed. The objection to a portable sander would be the same objection that applies to improvised sanders on lathe chucks—the difficulty of drawing off the dust.

In the foundry there is great scope for portable machines. There is, for instance, the hand-power sand sifter that can be easily moved from one end of the foundry to another, while the portable electric riddle is indispensable for mixing core sand, facing, and for general foundry use. Equally suitable are portable pneumatic riddles and separating machines; a few connections to the air mains at convenient points in the foundry being all that is required, with a length of hose-pipe sufficiently long to give a good working range.

Mechanical rammers, pneumatic chipping hammers, flexible shaft, and electric grinders are a few of the common types of foundry portable equipment. There are also useful bench core-making machines. As to whether compressed air or electricity is the better motive power is a matter about which there is not agreement.

J. McL.

Sterling

MOULDING BOXES

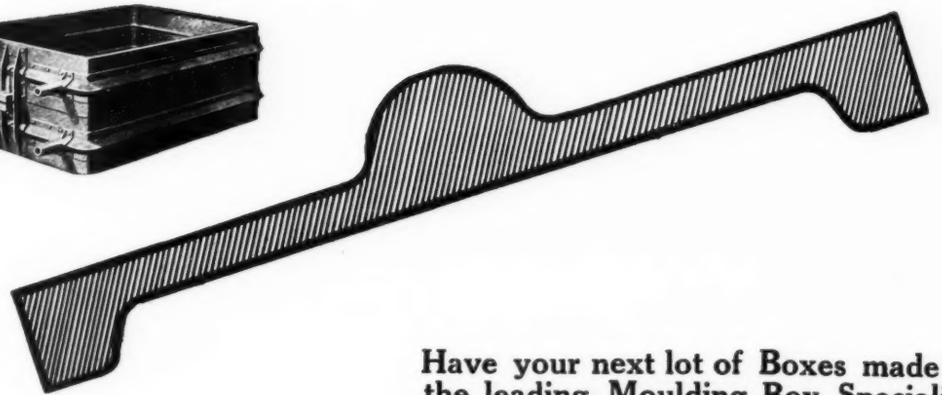
¶ LIGHTNESS AND EASE OF HANDLING;
¶ ROBUST CONSTRUCTION;
¶ DURABILITY AND LONG LIFE;
¶ PERMANENT ACCURACY.

These are the paramount essentials of the modern moulding box.

Sterling Boxes embody all these qualities. They are made from solid ribbed rolled steel of the special section shown below.

Some of the largest and most up-to-date foundries in the country are now completely equipped with Sterling Boxes.

All Sterling Boxes are made to suit the individual requirements of each Foundry. We will drill them to match up to your existing pattern plates or odd-sides and fit them with bars to suit your special patterns.



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WEEKLY PRICE CURRENT.

COPPER

	£ s. d.
Standard cash	61 17 6
Three months	61 17 6
Electrolytic	66 10 0
Tough	64 0 0
Best selected	64 5 0
Sheets	92 0 0
India	76 0 0
Wire bars	66 15 0
Do. April	66 15 0
Do. May	66 15 0
Ingot bars	66 15 0
H.C. Wire rods	71 10 0
Off. av. cash, Feb.	61 14 0½
Do. 3 mths., Feb.	61 6 7½
Do., Sttlmnt., Feb.	61 13 11½
Do., Electro, Feb.	66 12 0½
Do., B.S., Feb.	65 15 7½
Aver. spot price, copper, Feb.	61 14 0½
Do., Wire bars, Feb.	66 16 5
Solid drawn tubes	13d.
Brazed tubes	13d.
Wire	9½d.

BRASS.

Solid drawn tubes	11½d.
Brazed tubes	13½d.
Rods, drawn	10½d.
Rods, extd. or rlld.	7½d.
Sheets to 10 w.g.	10½d.
Wire	9½d.
Rolled metal	9½d.
Yellow metal rods	7½d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets	8½d.

TIN.

	£ s. d.
Standard cash	239 15 0
Three months	239 10 0
English	244 0 0
Bars	246 0 0
Straits	243 0 0
Australian	240 10 0
Eastern	243 5 0
Banca	245 0 0
Off. av. cash, Feb.	233 18 10½
Do., 3 mths., Feb.	236 1 3½
Do., Sttlmt., Feb.	233 18 6½
Aver. spot, Feb.	233 18 10½

SPELTER.

	£ s. d.
Ordinary	24 18 9
Remelted	25 5 0
Hard	20 0 0
Electro 99.9	29 5 0
English	25 7 6
India	21 10 0
Zinc dust	33 0 0
Zinc ashes	8 0 0
Off. aver., Feb.	25 10 2½
Aver., spot, Feb.	25 10 4¼

LEAD.

	£ s. d.
Soft foreign ppt.	20 5 0
English	21 10 0
Off. average, Feb.	20 10 3½
Average spot, Feb.	20 5 8

ZINC SHEETS, &c.

	£ s. d.
Zinc sheets, English	33 10 0
Do. V.M. ex whf.	32 0 0
Rods	39 0 0
Boiler plates	29 10 0
Battery plates	31 5 0

ANTIMONY.

	£ s. d.
Special brands, Eng.	58 0 0
Chinese	42 0 0
Crude	34 0 0

QUICKSILVER.

	£ s. d.
Quicksilver	22 7 6

FERRO-ALLOYS AND STEEL-MAKING METALS.

	£ s. d.
Ferro-silicon—	
25%	8 2 6
45/50%	12 17 6
75%	20 10 0
Ferro-vanadium—	
35/40%	14/3 lb. va.
Ferro-molybdenum—	
70/75%, c. free	4/6 lb.
Ferro-titanium—	
23/25% carbonless	11d.
Ferro-phosphorus, 20/25%	£17 15 0
Ferro-tungsten—	
80/85%, c. fr.	1/3 lb.
Tungsten metal powder—	
98/99%	1/7½ lb.
Ferro-chrome—	
2/4% car.	£32 15 0
4/6% car.	£22 8 0
6/8% car.	£22 5 0
8/10% car.	£22 5 0
Ferro-chrome—	
Max. 2% car.	£35 0 0
Max. 1% car	£40 0 0
Max. 0.70% car	£47 0 0
70%, carbonless	1/2 lb
Nickel—99%, cubes or pellets	£175 0 0
Ferro-cobalt	9/6 lb.
Aluminium 98/99%	£105 0 0
Metallic chromium—	
96/98%	2/10 lb.
Ferro-manganese (net)—	
76/80%, loose	£13 10 0
76/80%, packed	£14 10 0
76/80%, export	£13 5 0
Metallic manganese—	
94/96%, carbonless	1/10 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 6
Finished bars, 18% tungsten	£0 3 0

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to $\frac{1}{16}$ in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/-lb.
Bevels of approved sizes and sections	6d. lb.
Bars cut to length, 10% extra.	

Scrap from high-speed tool steel—	
Scrap pieces	3d.
Turnings and swarf	1d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£ s. d.	£ s. d.
South Wales—		
Hvy. steel	3 5 0	
Bundled steel and shrngs.	2 16 6	to 3 1 6
Mixed iron and steel	2 16 6	to 2 18 6
Heavy cast iron	3 0 0	
Good machinery for foundries	3 2 6	to 3 5 0
Cleveland—		
Heavy steel	2 17 6	
Steel turnings	2 9 6	
Cast iron borings	2 3 0	
Heavy forge	3 10 0	
Bushelled scrap	3 2 6	
Cast-iron scrap	3 2 0	to 3 6 0
Lancashire—		
Cast-iron scrap	3 5 0	
Hvy. wrought	3 2 6	
Steel turnings	2 2 6	

London—Merchants' buying prices delivered yard.

	£ s. d.
Copper (clean)	52 0 0
Brass (clean)	38 0 0
Lead (less usual draft)	17 10 0
Tea lead	15 10 0
Zinc	16 0 0
New aluminium cuttings	75 0 0
Braziery copper	47 0 0
Gunmetal	48 0 0
Hollow pewter	165 0 0
Shaped black pewter	125 0 0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	68/6
Foundry No. 3	66/-
Foundry No. 4	65/-
Forge No. 4	64/6
Hematite No. 1	70/6
Hematite M/Nos.	70/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	82/6
,, d/d Birm.	87/-
Midlands—	
Staffs. common*	—
,, No. 4 forge	62/6
,, No. 3 fdry.	64/-
Shrops. basic	—
,, Cold blast, ord.*	—
,, ,, roll iron*	—
* d/d Birmingham.	
Northants forge	—
,, fdry. No. 3	58/6 to 59/-
Derbyshire forge	60/-
,, fdry. No. 3	64/-
,, basic	—
Scotland—	
Foundry No. 1	—
,, No. 3	70/-
Hem. M/Nos.	75/-
Sheffield (d/d district)—	
Derby forge	64/6
,, fdry. No. 3	67/6
Lincs. forge	63/6
,, fdry. No. 3	67/-
E.C. hematite	82/6
W.C. hematite	85/-
Lincs. (at furnaces)—	
Forge No. 4	63/6
Foundry No. 3	67/-
Basic	66/-
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, fdry. No. 3	72/3
Northants foundry No. 3	—
Dalzell, No. 3	100/- to 102/6
Summerlee, No. 3	86/6 to 94/-
Glengarnock, No. 3	86/6 to 94/-
Gartsherrie, No. 3	86/6 to 94/-
Monkland, No. 3	86/6 to 94/-
Coltness, No. 3	86/6 to 94/-
Shotts, No. 3	86/6 to 94/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£ s. d.	£ s. d.
Bars (cr.) nom.	9 0 0	to 10 10 0
Angles		—
Tees to 3 united ins.		—
Nut and bolt iron		8 17 6
Hoops		12 0 0
Marked bars (Staffs.) f.o.t.		12 10 0
Gas strip		12 0 0
Bolts and nuts, ¾ in. × 4 in.		15 5 0
Steel—		
Ship plates	8 7 6	to 8 12 6
Boiler plts.		10 10 0
Chequer plts.		10 5 0
Angles		7 17 6
Tees		8 17 6
Joists		7 17 6
Rounds and squares, 3 in. to 5½ in.		7 10 0
Rounds under 3 in. to ⅜ in. (Untested)		7 15 0 and upwards
Flats, over 5 in. wide and up		8 17 6
Flats, 5 in. to 1½ in.		7 17 6
Rails, heavy	8 2 6	to 8 7 6
Fishplates		12 10 0
Hoops (Staffs.)		10 10 0
Black sheets, 24g.		10 2 6
Galv. cor. shts., 24g.		13 2 6
Galv. fencing wire 8g. plain		12 10 0
Billets, soft	£6 0 0	to 6 10 0
Billets, hard	£7 2 6	to 7 12 6
Sheet bars	£5 12 6	to 5 15 0
Tin bars	£5 12 6	to 5 15 0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1 2½
Sheet to 10 w.g.	1 3
Wire	1 3½
Rods	1 3
Tubes	1 8½
Castings	1 2

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	20.76
No. 2 foundry, Valley	17.25
No. 2 foundry, Birm.	16.00
Basic	18.76
Bessemer	19.26
Malleable	19.01
Grey forge	18.51
Ferro-mang. 80% d/d	100.00
O.-h. rails, h'y at mill	43.00
Bess billets	33.00
O.-h. billets	33.00
O.-h. sheet bars	34.00
Wire rods	44.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.85
Tank plates	1.85
Beams, etc.	1.85
Skelp, grooved steel	1.85
Skelp, sheared steel	1.85
Steel hoops	2.20
Sheets, black, No. 24	2.90
Sheets, galv., No. 24	3.65
Sheets, blue an'l'd., 9 and 10	2.10
Wire nails	2.65
Plain wire	2.50
Barbed wire, galv.	3.35
Tinplate, 100 lb. box	$5.25

COKE (at ovens).

Welsh foundry	—
,, furnace	—
Durham and North.	
,, foundry	—
,, furnace	14/-
Other Districts, foundry	—
,, ,, furnace (basis)	12/- to 13/-

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes	20×14	box	18/-
,,	28×20	,,	36/-
,,	20×10	,,	—
,,	18¾×14	,,	—
C.W.	20×14	,,	16/10½
,,	28×20	,,	—
,,	20×10	,,	—
,,	18¾×14	,,	—
Terneplates	28×20	—	per box basis f.o.b.

SWEDISH IRON.

Bars, hammered, £17 10 0	to £18 10 9
Rolled Ord. £15 0 0	to £15 10 0
Nail rods £15 7 6	to £15 15 0
Keg. steel nom.	£33 to £35
Faggot steel nom.	£22 to £25
Blooms, according to quality	£8 to £12
Pig-iron £5 15 0	to all f.o.b. Gothenburg.

TUBES AND FITTINGS.

Up to and incl. 6 in.

	Tubes.	Fittings.
Gas	67½%	45%
Water	63¾%	40%
Steam	60%	35%
W.I. 10% extra.		

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.		
Mar. 29 ..	61	16	3	inc.	3/9
,, 30 ..	61	18	9	,,	2/6
April 2 ..	61	18	9	No change	
,, 3 ..	61	17	6	dec.	1/3

Electrolytic Copper.

	£	s.	d.		
Mar. 29 ..	66	10	0	No change	
,, 30 ..	66	10	0	,,	,,
April 2 ..	66	10	0	,,	,,
,, 3 ..	66	10	0	,,	,,

Standard Tin (cash).

	£	s.	d.		
Mar. 29 ..	238	10	0	inc.	10/–
,, 30 ..	239	0	0	,,	10/–
April 2 ..	241	0	0	,,	40/–
,, 3 ..	239	15	0	dec.	25/–

Tin (English ingots).

	£	s.	d.		
Mar. 29 ..	243	10	0	inc.	10/–
,, 30 ..	244	0	0	,,	10/–
April 2 ..	246	0	0	,,	40/–
,, 3 ..	245	0	0	dec.	20/–

Zinc Sheets (English).

	£	s.	d.		
Mar. 29 ..	33	10	0	No change	
,, 30 ..	33	10	0	,,	,,
April 2 ..	33	10	0	,,	,,
,, 3 ..	33	10	0	,,	,,

Spelter (ordinary).

	£	s.	d.		
Mar. 29 ..	25	2	6	inc.	2/6
,, 30 ..	25	0	0	dec.	2/6
April 2 ..	24	18	9	,,	1/3
,, 3 ..	24	18	9	No change	

Lead (English).

	£	s.	d.		
Mar. 29 ..	21	10	0	No change	
,, 30 ..	21	10	0	,,	,,
April 2 ..	21	10	0	,,	,,
,, 3 ..	21	10	0	,,	,,

AVERAGE MONTHLY PRICES OF IRON HOOPS.

	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1896	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 5 0	6 10 0	6 3 4
1897	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0
1898	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 15 0	6 15 0	7 0 0	6 11 8
1899	7 0 0	7 0 0	7 0 0	7 0 0	7 12 6	10 12 6	8 12 6	8 12 6	8 12 6	9 2 6	9 7 6	9 17 6	8 2 6
1900	9 17 6	10 7 6	10 7 6	10 7 0	10 12 6	7 12 6	10 12 6	10 12 6	10 12 6	9 17 6	9 2 6	9 2 6	9 3 9
1901	9 2 6	8 2 6	8 2 6	7 12 6	7 12 6	7 12 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 11 8
1902	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6
1903	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6
1904	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6
1905	6 17 6	7 0 0	7 0 0	7 0 6	7 0 0	7 0 0	7 2 6	7 2 6	7 2 6	7 7 6	7 5 0	7 7 6	7 1 8
1906	7 10 0	7 17 6	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	8 7 6	7 15 10
1907	8 7 6	8 7 6	8 7 6	8 7 0	8 7 6	8 7 6	8 10 0	8 10 0	8 10 0	8 5 0	8 5 0	8 5 0	8 7 1
1908	8 0 0	7 10 0	7 10 0	7 10 6	7 10 0	7 10 0	7 10 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 6 8
1909	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0
1910	7 1 10½	7 6 3	7 7 6	7 7 0	7 7 6	7 7 6	7 7 6	7 7 6	7 7 6	7 6 3	7 5 0	7 5 0	7 6 5½
1911	7 5 0	7 5 0	7 5 0	7 5 6	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 8 9	7 10 0	7 10 0	7 6 1½
1912	7 12 6	7 12 6	7 12 6	7 15 0	7 15 0	8 2 6	8 2 6	8 2 6	8 12 6	8 12 6	8 12 6	8 15 0	8 2 3½
1913	8 17 6	8 17 6	8 17 6	8 17 0	8 17 6	8 17 6	8 17 6	8 7 6	8 7 6	8 7 6	8 7 6	7 17 6	8 12 6
1914	7 17 6	7 17 6	7 17 6	7 13 9	7 12 6	7 12 6	7 12 6	9 2 6	9 2 6	9 2 6	9 2 6	9 2 6	8 6 4½
1915	9 3 6	9 18 1	10 7 6	10 16 6	10 17 6	13 2 6	13 2 6	13 2 6	13 7 6	14 2 6	15 2 6	15 18 6	12 10 1½
1916	17 2 6	17 2 6	17 2 6	17 6 3	17 7 6	17 7 6	17 7 6	17 7 6	17 7 6	17 7 6	17 7 6	17 7 6	17 6 1½
1917	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6
1918	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6
1919	17 2 6	17 2 6	17 2 6	17 2 6	24 6 3	24 6 3	24 6 3	25 9 0	26 7 6	26 7 6	26 7 6	26 17 4	22 14 9
1920	28 0 0	28 12 6	33 15 0	35 5 0	35 15 10	38 17 6	38 17 6	38 17 6	38 17 6	38 17 6	36 17 6	36 17 6	35 14 9
1921	29 1 3	23 5 0	21 12 6	20 0 0	20 0 0	20 0 0	17 5 0	15 0 0	14 4 0	13 15 0	13 10 0	12 18 0	17 5 10
1922	16 5 0	15 13 9	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	13 4 6½
1923	14 0 0	15 0 0	15 0 0	15 0 0	15 6 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	14 16 0	14 15 0	14 18 3½
1924	14 15 0	14 15 0	14 15 0	14 15 0	14 15 0	14 13 9	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 12 4½
1925	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0
1926	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0
1927	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	12 10 0	12 10 0	14 3 4
1928	12 10 0	12 7 6	12 0 0	—	—	—	—	—	—	—	—	—	—

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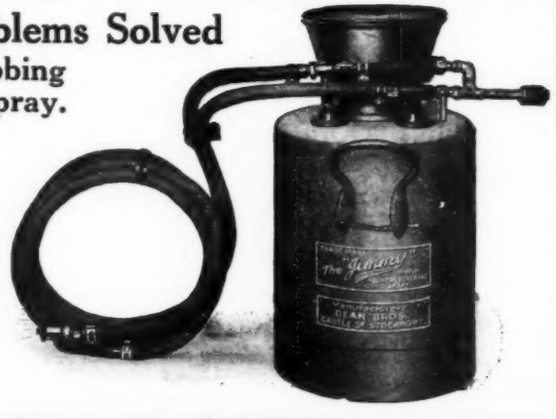
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